
DAIRY CATTLE

SELECTION, FEEDING
AND MANAGEMENT

W. W. YAPP & W. B. NEVENS

CFTF MYSORE



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Dairy cattle: Se

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THE WILEY FARM SERIES

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DAIRY CATTLE

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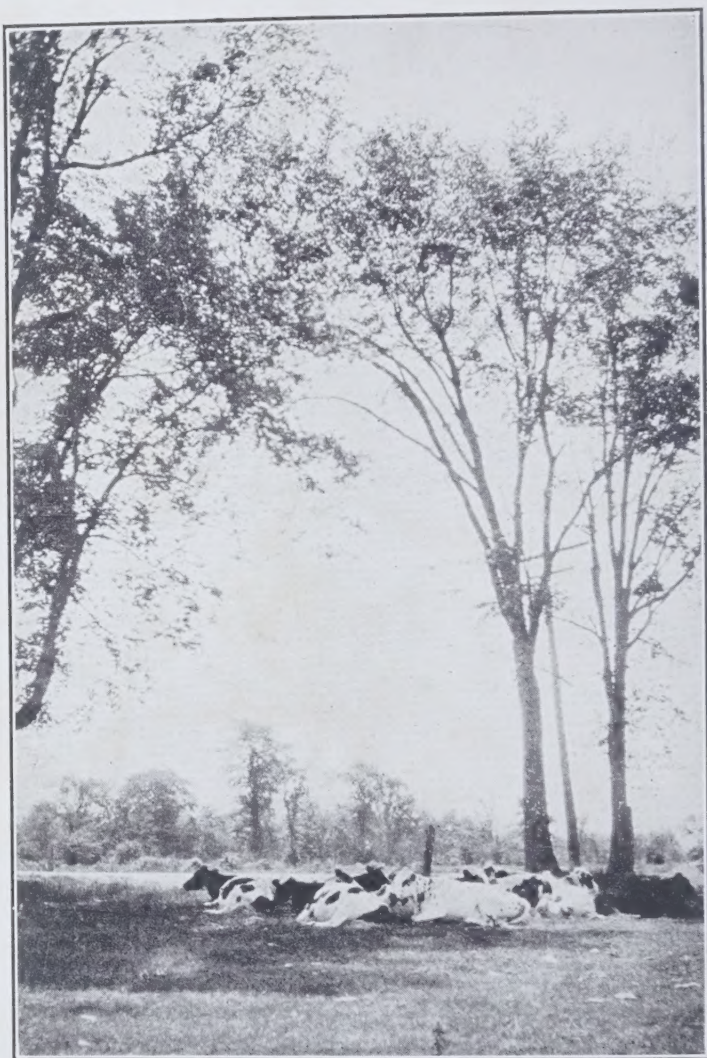
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DAIRY CATTLE ARE ESSENTIAL TO THE NATION'S WELFARE

The health and continued well-being of the people of this country are dependent upon a liberal use of milk in the diet.

DAIRY CATTLE

SELECTION, FEEDING AND MANAGEMENT

BY

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THIRD EDITION
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Dairy cattle: Se.

WILBER JOHN FRASER

OUR TEACHER, COLLEAGUE, AND FRIEND;

A PIONEER, A BLAZER OF NEW TRAILS,

AND ONE OF THE TRUEST FRIENDS

THE DAIRY INDUSTRY HAS EVER KNOWN

TO HIM,

THIS BOOK IS DEDICATED

THE AUTHORS

PREFACE

Many new developments in the fields of animal breeding, nutrition, and physiology have occurred since the second revised edition of "Dairy Cattle" was issued in 1930. An attempt has been made in the present edition to incorporate these recent developments in an interesting, practical, and authoritative manner.

A new chapter has been added in which the principles of genetics as applied to dairy cattle breeding are simply and clearly explained. These explanations give a good background for the completely revised chapter on dairy-cattle breeding which follows.

Radical changes in economic conditions which have occurred since the previous edition was issued have focused the attention of dairy farmers more strongly than before on the financial returns from their business. Some of the features of herd management which have important bearings on income are discussed in a new chapter, "Studying the Factors Affecting the Returns from the Dairy Enterprise."

Numerous discoveries in the field of nutrition have been made, particularly with reference to the functions of vitamins and minerals. These discoveries have led to new applications in the feeding of dairy cattle and in methods of preserving and preparing feeds.

A consideration of the future possibilities of dairy farming is found in a new and final chapter, "Providing a Sound Basis for the Future."

The authors are indebted to Dr. L. E. Boley of the Division of Animal Pathology and Hygiene, University of Illinois, for valuable suggestions in the revision of Chapter XVI, and to

Professor R. H. Wilcox of the Department of Agricultural Economics, University of Illinois, for a critical review of Chapter XVII. They also acknowledge the courtesy of the University of Illinois in permitting the use of photographs, experimental data, and other findings.

THE AUTHORS

JANUARY, 1941

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SUGGESTIONS TO TEACHERS

Some recent developments in secondary agricultural education in the middle-western states favor the distribution of the different teaching fields throughout the year. This gives the student opportunity to follow each of his subjects for a part of each year instead of devoting an entire year to one subject. The authors, in recognition of this development, suggest the following order of study:

First year, Chapters 1, 2, 3, 4, 5.

Second year, Chapters 11, 12, 13, 14, 15.

Third year, Chapters 8, 9, 10, 16, 17, 18.

Fourth year, Chapters 6, 7, 19, 20, 21, 22.



DAIRY CATTLE MAKE GOOD USE OF PASTURES ON UNTILLABLE LAND

A large portion of the pasture grass on rough, stony, or wooded areas in the eastern half of the United States is utilized by dairy cattle. In this way an enormous amount of coarse feed, which without dairy cows could not be used economically, is converted into nutritious human food.

DAIRY CATTLE

CHAPTER I

SHALL I BE A DAIRY FARMER?

Almost every small boy has at some time during his early years definitely settled, in his own mind, his choice of a career. This decision is almost always occasioned by some event, insignificant in itself, that has appealed to an imagination supercharged at that age, and the selection varies all the way from driving a garbage wagon to becoming president of the United States. Such careers seem real to the individual at the time, but experience shows that seldom do any of them have any direct permanent influence upon the final choice of a life's work.

Sooner or later, however, there must come into the life of every man a time when it is necessary for him to decide what he will do and what he hopes to be. Some careful planning at this point, followed by persistent, conscientious effort, creating opportunities when apparently opportunities do not exist, will eventually carry one to the goal of his ambitions.

Any important decision that will seriously affect or that may ultimately determine a career should be carefully considered in light of all the facts that might be regarded as having a bearing upon such choice. To do less than this would be a decided reflection upon the significance of a life's work.

1. DO I HAVE THE QUALITIES OF A DAIRY FARMER?

In order to succeed in any industry it is desirable, in fact necessary, for those engaged in the business to be in possession of certain characteristics basic to accomplishment in that

industry. Most men who are themselves capable in the management of dairy cattle have certain attributes common to all good dairymen.

Qualities of a good dairy farmer:

- A. Fondness for animals.
- B. Willingness to work day after day for long hours.
- C. Capacity for attending to details.
- D. A cooperative spirit in community dairy enterprises.
- E. An understanding of the basic principles of breeding and feeding.
- F. Ability to overcome disappointments.

A. Fondness for animals. Very rarely will a man be successful with livestock without possessing a fondness for animals. No man can derive any satisfying pleasure from working with animals unless he has a genuine love for them. Such liking for animals will take the drudgery out of going to the barn at night to make sure that they are comfortable and will cause one to fight for an animal that is being abused.

Furthermore, animals react favorably to attention and kindly treatment. Not long ago one of the authors noticed that the heifers in a certain herd, after having their first calves, kicked badly when they were broken to milk. It was not just one but the majority of the heifers that reacted in this way. The condition was so unusual that observations were made to determine the cause. After several weeks of careful study it was decided that the trouble originated in the calf barn. Thereupon, a new man with a different temperament and a fondness for calves was placed in charge, and when animals reared by this man came into milk the trouble completely disappeared. The first man, on the contrary, had been nervous; he had hurried and prodded the calves and it was noticed that the "little fellows" would run from him and kick at him when his back was turned. Kindness and a fondness for the calves on the part of the new man, which they

appreciated, completely changed the reaction of the heifers to their surroundings.

B. Willingsness to work day after day for long hours. For one who likes cattle, the work of caring for them is a pleasure even though it entails difficult tasks, is definitely confining, and involves long hours. Although there is no type of farming that requires more personal attention or closer application to business than dairying, there is in all probability no other type of farming which yields higher and more certain returns.



FIG. 1. DAIRY FARMING OFFERS MANY REWARDS

The owner of a dairy farm has the assurance of frequent and regular income from his readily marketed produce. His is a relatively secure type of farming in that soil fertility tends to be maintained, the market for dairy products is relatively stable, and there is year-round utilization of both family and hired labor.

C. Capacity for attending to details. It requires a higher-type and more capable man to be a good dairyman than to be an equally successful grain farmer. The dairyman has more details to attend to and many more specialized jobs to perform than the general farmer. He is really managing two businesses. In growing his crops he is a grain farmer, and in managing his herd he is a dairyman.

D. A cooperative spirit in community dairy enterprises. Many of the control measures and informational practices of the successful dairy farmer are community enterprises. Dairy-herd improvement associations, bull clubs or breeding circles, marketing agencies, etc., are, or can be made to be,

cooperative in nature. Too active a participation in the management of such enterprises may consume a large portion of the time of the dairyman and thereby produce an unfavorable effect upon his farm operations and his income. In general, however, membership and participation in the activities of such organizations is advantageous.

E. An understanding of the basic principles of breeding and feeding. The productive ability of any dairy cow is determined first by the potential ability which she inherits from her ancestors, and second by the opportunity which she has to express that talent usually called environment. Both breeding and feeding, particularly the latter, have been the subject of much study and experimentation. The most successful dairymen try to take advantage of the more important discoveries in both fields.

F. Ability to overcome disappointments. It is not easy to do everything in one's power and then have a valuable animal sicken and die. It is at such a time that a person's courage is thoroughly tested. Unless a dairyman can endure such disappointments he will sooner or later become discouraged and this is one of the first signs of approaching failure. The true dairyman will then recover quickly, try to profit by the experience, and if necessary put more effort into his work and find his reward in a successful enterprise.

2. DAIRY FARMING—A BUSINESS OF FOOD PRODUCTION

Agriculture may properly be regarded as a business of food production.¹ Its products, in one form or another, supply the nourishment which makes our bodies grow and furnishes the energy that enables us to work and to play. The food products of agriculture may be separated into two general classes based upon the manner in which they are used for human food. These classes are primary foods and secondary

¹ When the product is consumed by people it is considered food, when eaten by animals it is spoken of as feed.

foods. Primary foods are those which are eaten directly, requiring no special treatment other than cooking. Examples are wheat, corn, oats, barley, potatoes, fish, and oysters. Secondary foods are the products of animals and have been produced from the consumption of feeds by these animals. Meat, milk, eggs, and honey are examples of secondary foods.



FIG. 2. DAIRY FARMING HOLDS THE INTEREST OF THE ENTIRE FAMILY

Dairy calf-club projects early instill a love of cattle and farm life into farm boys and girls. This fifteen-year-old girl won numerous awards for her skill in showmanship.

Primary foods, when measured in terms of total energy, constitute approximately 61 per cent of all the foods consumed in continental United States; whereas, secondary foods, evaluated on the same basis, make up 39 per cent of our diet. Measured in terms of protein (muscle-building foods) and carbohydrates and fats (energy-producing foods), secondary foods supply approximately as much protein, one-sixteenth the

amount of carbohydrates and five times as much fat (fat has an energy value 2.25 times that of carbohydrates) as primary foods. Primary foods have an advantage from a quantitative standpoint; secondary foods are usually considered superior from a qualitative basis.

The dairy industry is a division of agriculture unique in that the products which it produces are consumed almost entirely by people. Of all the foods that we eat, milk is probably the most completely and easily digested. Furthermore, it is more nearly balanced for the needs of the human body than any other single food. It contains essentially all the substances known to be necessary for growth and development. Milk is rich in vitamins as well as in the mineral substances that are required for bone formation and is necessary for controlling certain of the body functions. Milk is slightly deficient in iron, and were milk used as the sole food in one's diet, it would be necessary to supply more of the iron substance.

Since the dairy industry is engaged in the production of so vital a food product, it appears almost certain that it is destined to be an abiding industry. Furthermore, since its products are consumed almost entirely by people, its growth should, to some degree, follow the development in population. Any person who considers engaging in dairy production, or making a life work of some associated or dependent business, would do well to consider some facts about the industry.

3. FACTORS THAT COMMEND THE INDUSTRY

The fact that there are in the United States 604,837 specialized dairy farms ² and that approximately 23,750,000 cows are kept for dairy purposes is sufficient evidence to convince one that there is much interest in the dairy business.

Advantages accorded the industry:

- A. Good dairy cows are efficient producers of human food.
- B. Dairy farming aids in conserving the fertility of the soil.

² U.S. D. A. 1930 Census.

- C. Dairy cattle yield a high cash return for roughages, pasture, etc.
- D. Dairy cattle furnish a home market for farm products.
- E. Dairying furnishes a market for labor.
- F. It provides a continuous cash income.
- G. Products of industry consumed by people.

A. Good dairy cows are efficient producers of human food.

If it ever came to a question of maintaining the largest number of people on a given area, it would be accomplished by feeding the products of that area as primary foods. Feeding grains and seeds to animals and using the animal products produced thereby for human food does not ordinarily result in the most efficient use of such food products. When the qualitative values of foods are considered, however, and the best nutrition of the human race is at stake, a liberal use of secondary foods in the form of animal products is recommended.

Animals vary widely in the relative efficiency with which they are capable of converting feeds and fodders into secondary foods. This fact is illustrated in Table I in which certain farm animals, as well as a few of our more common crops, are compared in efficiency of energy production.

In this table the acre is considered as the unit of production. With animals, it is assumed that the crops produced are fed in such a way as to supply the necessary nutrients in essentially the proper proportions for maximum production. In certain instances this means dividing the area and growing two or more crops in order to provide the proper nutritive ratio for the animal considered.

From a study of Table I, it is to be observed that the dairy cow produces, in the form of milk, more human food from the products of an acre of land than does any other farm animal. This is true for both digestible protein and therms of energy.³ It will be noted that hogs rank second, easily the most effi-

³ A therm of energy is equivalent to 1000 large calories, and a large calorie represents the amount of energy required to raise the temperature of one liter (slightly more than 1 quart) of water 1° C.

TABLE I

HUMAN FOOD FROM AN ACRE OF FARM CROPS—UTILIZED AS PRIMARY AND SECONDARY FOODS *

	Yield	Yield	Human Food per Acre	
			Digestible Protein	Energy
	Bushels	Pounds	Pounds	Therms
Primary Foods:				
<i>Crop</i>				
Corn.....	35	1960	147.0	3124.2
Irish potatoes.....	100	6000	66.0	1908.0
Wheat.....	20	1200	110.4	1788.0
Rice (polished).....	40	1086	50.0	1581.2
Soybeans.....	16	960	294.7	1534.0
Peanuts.....	34	524	126.2	1265.0
Oats.....	35	784	89.4	1254.4
Secondary Foods:				
<i>Dairy Product</i>				
Milk.....		2190	72.3	711.8
Cheese.....		219	56.7	427.0
Butter.....		99	1.0	355.3
<i>Meat</i>				
Pork.....	350 lb.	273	22.7	672.9
Poultry.....	267 lb.	171	33.0	178.7
Mutton.....	205 lb.	113	14.7	137.3
Eggs.....	122.4 doz.	184	24.6	132.2
Beef.....	216 lb.	125	18.5	130.0

* U.S.D.A. Farmers' Bul. 877, 1917.

cient of all meat-producing animals listed. This observation might suggest that the dairy cow and hog constitute a desirable and efficient combination. In regions where cream is produced

and skim milk remains as feed on the farm, the combination has worked well.

Not only is the dairy cow high in the efficiency with which she is able to produce human food and in the quality of her product, but she also ranks high in total production. Approximately 44 per cent of the foods of animal origin are the products of dairy cows. The dairy cow occupies a ranking position among food-producing animals.

B. Dairy farming aids in conserving the fertility of the soil. Unless some provision is made to replenish the elements of plant food taken from the soil in ordinary grain farming, there is a material reduction in plant food with each succeeding harvest. When crops are fed to animals and the manure from them returned to the soil, less plant food is taken from the farm.⁴

It must be borne in mind, however, that fertility cannot be maintained by returning to the soil an amount of manure equivalent to that produced by animals consuming only the crops produced on the farm. Even when the manure returned to the soil includes the products from purchased feeds, it will not in most instances maintain crop yields.

There is a tendency for many soils, even though heavily manured, to become deficient in calcium and show an acid reaction after continued cropping. In such an event it is necessary to add limestone or some similar substance to correct the acidity and supply the necessary calcium.

Dairying furnishes an added incentive to grow legume crops for such crops provide a cheap source of protein for dairy cattle, supply minerals in a desirable form, and at the same time furnish the principal basis for soil improvement. Furthermore, the dairy farm by carrying a high percentage of its area in pasture or hay land tends to retard or reduce the amount of erosion. Table II compares some of our more common

⁴ See Chapter XXI for tables showing the elements of plant food in common farm crops and the plant-food elements in roughages and barn manure.

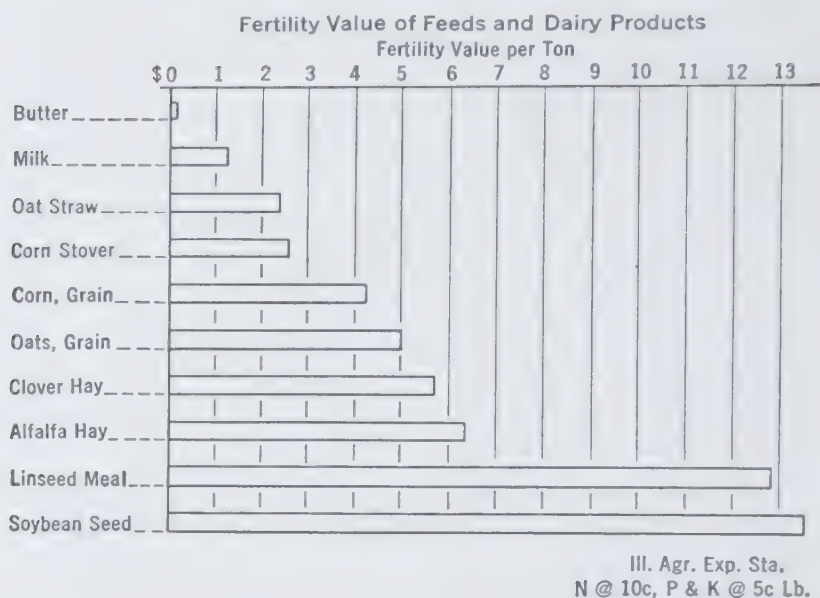


FIG. 3. DAIRY PRODUCTS ARE POOR FERTILIZERS

Legume hays have a fertility value worth \$5 to \$6 a ton, and the high-protein feeds \$10 to \$13 a ton. Dairy products, on the other hand, are very low in fertility value. Dairy farmers are in an advantageous position in being able to retain high-fertility products on the farm and to market products that draw only small amounts of the fertility from their soil.

TABLE II

EFFECT OF CROPPING SYSTEMS ON EROSION

Experiments Conducted on Gently Sloping Field of Loam Soil
(Slope 4 inches vertical to 100 horizontal)

Type of Crop	Tons Soil Eroded in 6 Years	Years Required to Erode 7 Inches of Top Soil
Not cultivated—weeds pulled.....	208	29
Spaded 4 in. in spring fallow.....	247	24
Spaded 8 in. in spring fallow.....	214	28
Corn each year—spaded 8 in. in spring.	106	56
Wheat—annually spaded 8 in. in July.	40	150
Corn, wheat, clover spaded 8 in. for corn.	14	437
Bluegrass sod.....	2	3547

crops with respect to erosion prevention. It is readily apparent that cultivated crops compare unfavorably with grass crops and legumes in erosion control.

C. Dairy cattle yield a high cash return for roughages, pasture, etc. There are on every farm certain waste feeds which do not have a direct and ready cash market. Milk or cream, on the other hand, is always in demand and possesses a direct cash value. It is important from the standpoint of the farm income that these waste products be utilized. Since the dairy cow is capable of using such feeds with a higher degree of efficiency than other farm animals, she makes a desirable market for their utilization. Dairy cows are especially valuable in marketing pasture crops. When special pastures, such as sweet clover, are so marketed they yield high acre returns.

D. Dairy cattle furnish a home market for farm crops. Farm products, especially roughages, are extremely bulky. It is desirable that they be consumed near the source of production and a less bulky product marketed in their stead. Dairy products, particularly cream, are not especially bulky and for this reason offer an advantage in marketing. The establishment of desirable crop rotations, developed with the idea of conserving the fertility of the soil, demands the production of legume crops, which are especially bulky and in many sections not readily marketable. Their conversion into milk or butterfat on the farm, therefore, not only furnishes a cash market, but also reduces the marketing problem.

E. Dairying furnishes a market for labor. Men working in the crafts receive a high hourly or daily wage. Their yearly income, however, is not large because they actually work a relatively small percentage of the year, in many instances only 150 or 200 days. Certain types of farming have tendencies in the same direction in that many of the farming operations are seasonal in nature. The farmer usually experiences difficulty in finding profitable employment during the remainder of the year. Under such conditions dairying

furnishes a profitable market for extra labor. Furthermore, cows require a maximum of attention during the winter months, and a minimum during the summer season when crops make the greatest demands on labor.

Much of the work of caring for cows can be easily and quickly done. The nature of the work is such that the family, especially the older children, can readily assist in its accomplishment. Such work is in no sense harmful unless it

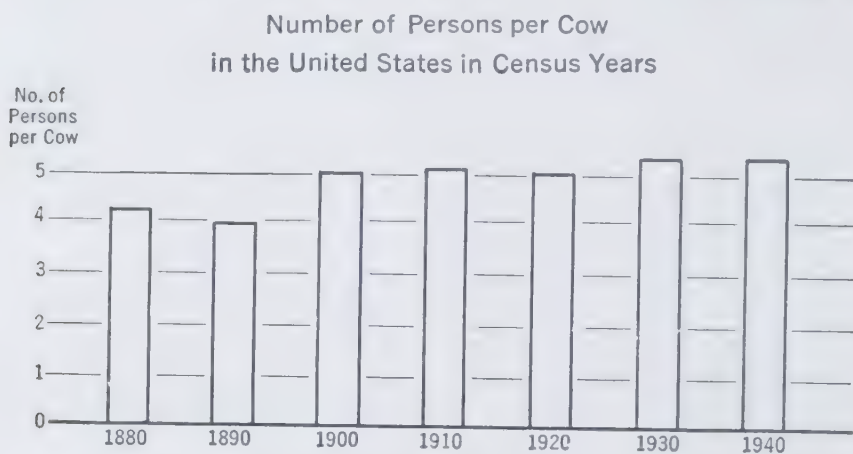


FIG. 4. A COW FOR EVERY FAMILY

Dairy cows in the United States number about one for every five persons, or about one to a family. There has been a slight increase in the number of persons supplied dairy products by each cow, presumably because of higher yields per cow and in spite of an increase in consumption of dairy products per capita.

involves long hours or prevents the children from attending school.

F. It provides a continuous cash income. It is the history of many business enterprises that they ultimately fail for the want of sufficient operating capital. Many farms are less productive and less profitable than they could be made to be if the operator had more capital at his disposal. The dairy business is one which supplies a continuous income and therefore in a sense provides its own operating capital. In this respect the dairyman possesses many of the advantages enjoyed by the man who receives a salary.

G. Products of industry consumed by people. It is significantly important to the dairy industry that its products are consumed largely by people. This fact alone, providing present per capita consumption remains the same, insures a probable expansion in proportion to population. With a rather marked increase in per capita consumption (a condition which has obtained for many years) a correspondingly greater demand will prevail. Contrast this situation with that of corn for instance in which practically four-fifths of the annual production is consumed by animals. Under such conditions any material decrease in animal population would necessarily release a proportionate amount of corn for other sources of consumption.

4. DISADVANTAGES OF THE INDUSTRY

It would be unfair to present only the advantages claimed for the dairy industry without at the same time presenting objectionable features. Dairy farming, like most other businesses, has certain inherent characteristics generally regarded as undesirable.

Disadvantages of dairying:

- A. Dairying is confining and requires long working hours.
- B. Dairy farming requires the investment of considerable capital.
- C. It is often difficult to obtain desirable labor.
- D. General hazards, losses due to disease, accidents, etc., are high.
- E. Substitutes for dairy products are being developed.

A. Dairying is confining and requires long working hours. In this country cows are milked and fed at least twice each day. To do this some one must be available every night and morning. In the larger dairies it means a considerable working force; in the smaller herds the feeding and milking is most often done before and after a regular day of work in the field. This prolongs the working day, shortens the period for rest and sleep, and tends to reduce the general stamina and resistance to disease of the worker.

B. Dairy farming requires the investment of considerable capital. Dairying involves a larger investment in buildings and stock than does grain farming. Time, however, especially in the production of registered cattle, can be substituted for capital. Wisely made, a relatively small investment can, by the normal increase in the number of cattle over a period of time, develop a herd that would require a large capital investment if it were procured at one time.

One of the authors is familiar with two herds of cattle that have descended from a single cow, purchased as a calf. In fifteen years, the time interval involved, these herds numbering thirty-five and twenty-three head of females, respectively, and valued at \$12,500 were produced. During the same time animals worth \$5800, not included in the herds indicated, were sold from the farm. In other words, a young man with limited capital can develop, in time, a valuable herd of cattle.

C. It is often difficult to obtain desirable labor. For many years there has been an inclination for young men reared on the farm to seek urban employment. This has made it difficult to obtain a sufficient number of desirable workers on the farm, particularly in sections near centers of population.

Often grain farmers are not good hand milkers and do not enjoy working with cows. When the herd is large enough to employ regular men by the year, it is not so difficult to secure desirable help. When the herd is small and transient help is employed, the family usually has to do the milking. This situation limits the size of such dairy herd. Machine milking and other labor-saving devices not only remove much of the drudgery from dairying but also are responsible for more sanitary conditions and products.

At the present time there appears to be some indication that urban labor is seeking rural employment. If this condition persists, the labor shortage of the dairyman will probably disappear.

D. General hazards, losses due to disease, accidents, etc., are high. Table III shows the number of animals that have

reacted under the federal plan to the agglutination test for abortion from July 1, 1934, to December 1, 1939. This loss has amounted to 4.8 per cent of the animals tested for the period covered. It should be observed that the percentage reactions are becoming progressively lower, indicating a definite trend on the part of livestock men to control this disease.

Table IV shows the reasons why cows are eliminated from herds tested for production in dairy-herd-improvement asso-

TABLE III *

BANG'S DISEASE ERADICATION

(July 1, 1934–December 31, 1939)

Year	Herds Tested	Cattle Tested	Reactors	Per Cent Reactors
July to January, 1934— 6 Mo. Only	78,782	624,318	9,874	1.6
1935	368,937	5,391,404	481,734	8.9
1936	585,213	7,690,376	433,985	5.6
1937	614,235	7,679,714	342,413	4.5
1938	737,815	8,072,390	291,509	3.6
1939	665,137	7,137,066	183,375	2.6
Total.....	3,050,119	36,595,268	1,742,890	4.8

* U.S.D.A. plan.

ciations. The results given represent the observations made in Illinois from January 1, 1938, to December 31, 1939.

While losses are sometimes high, it must be kept in mind that good management will assist greatly in reducing them to a point where they do not seriously endanger the success of the enterprise.

E. Substitutes for dairy products are being developed. The wise dairy farmer does not close his eyes to the fact that good substitutes for dairy products are being developed. Com-

TABLE IV
DATA SHOWN BELOW INDICATE WHY COWS ARE CULLED
(1938 and 1939)

Cause	Number of Cows	Per Cent of Total
Low production.....	5318	50.7
Udder trouble.....	1073	10.2
Abortion.....	1153	11.0
Sterility.....	833	7.9
Died.....	687	6.6
Old Age.....	434	4.1
Tuberculosis.....	288	2.7
Accident.....	270	2.6
Other reasons.....	433	4.1

petitive products of this type are certain to have much money and talent expended in their improvement and production. Efficiency on the part of the dairyman, enabling him to sell his products at a lower price, together with the production of a better-quality product, will discourage such competition.

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CHAPTER II

FACTORS AFFECTING THE RETURNS FROM THE DAIRY ENTERPRISE

A person who has decided to make dairy farming his specialty should carefully consider the factors that are likely to affect the returns from the enterprise. Too many men begin farming with the thought that most farms are successfully operated and return good incomes. They fail to study the reports of farm-management investigations which point out in unmistakable terms wide differences in the incomes of farmers within a community. They may continue to struggle on for many years in ignorance of methods which, if adopted on their farms, would give them much greater rewards for their efforts.

Management problems:

1. Determining the qualifications of a successful dairy farmer.
2. Selecting the class of cattle best suited to a dairy enterprise.
3. Choosing the most profitable cows.
4. Studying the economy of high production.
5. Obtaining a high proportion of productive units.
6. Combining good business and good-management practices.
7. Determining the relation of market prices to returns.

1. DETERMINING THE QUALIFICATIONS OF A SUCCESSFUL DAIRY FARMER

A successful dairy farmer, first of all, must be a good manager of dairy cattle.

Secondly, he must understand and use good methods of crop production. In other words, dairy farming consists of

two lines of work, each of which requires special knowledge and skill. Either phase of the dairy-farm enterprise may be operated at a profit or at a loss. It is obvious that for satisfactory returns both phases must be carried out efficiently. Hence, the successful operation of a dairy farm calls for the exercise of greater ability on the part of the manager than only the performance of a herdsman's duties or only the management of a grain and grass farm. On the other hand, greater rewards are possible for the person capable of combining the direction of these various lines of production into the successful management of a dairy farm.

Thirdly, a successful dairy farmer must be capable of performing certain managerial functions entirely aside from physical labor. He must study and decide upon the amounts of capital and labor to be employed and the number of enterprises to be undertaken; he must determine the form in which the products are to be marketed and the best available markets; and he must give careful attention to other factors, such as: (a) the efficiency of the labor employed with respect to the amount of milk produced per man; (b) the returns from \$100 worth of feed; and (c) the receipts per unit of capital invested.

2. SELECTING THE CLASS OF CATTLE BEST SUITED TO A DAIRY ENTERPRISE

The dairy breeds of cattle have been developed to their high state of efficiency as milk producers through many years of careful selection. Breeders have sought those characteristics which make for high and long-continued production and have endeavored to perpetuate these characters through the elimination of undesirable animals. Breeders of beef cattle, on the other hand, have brought the beef-cattle breeds to a high state of efficiency as producers of good-quality beef. It is not expected that very high milk production and the production of high-quality beef can be combined in the same

animal. Dairy farmers, therefore, have usually found it more profitable to keep one of the dairy breeds, especially in areas where most of the product is sold as whole milk.

The dual-purpose breeds find a useful place on farms that have available large quantities of pasture and other unsal-



FIG. 5. HIGH-PRODUCING COWS OF THE DAIRY BREEDS ARE USUALLY BEST FOR THE DAIRY ENTERPRISE

The dairy farmer who has a good market for dairy products usually finds that high-producing cows of the dairy breeds are more profitable than cows of the dual-purpose or beef breeds. Efficient cows, such as the ones pictured here, are found in the most prosperous dairy sections.

able roughage, providing good markets for butterfat are available. Dual-purpose cattle and beef-cow herds usually consume a cheaper grade of roughage than is required for dairy herds. The keeping of livestock to consume much of the roughage has a very favorable influence on crop yields.

The returns from dairy-cow herds, beef-cow herds, and dual-

purpose cow herds on farms in the grain-growing sections of Illinois are shown in Table V. These averages of three-year comparisons show that the dairy-cow herds returned greater incomes for each \$100 worth of feed fed than did either of the other groups. These figures, however, were obtained from

TABLE V *
KIND OF CATTLE ENTERPRISE AS RELATED TO RETURNS PER
\$100 WORTH OF FEED FED

	Dairy-cow Herd	Beef-cow Herd	Dual- purpose Cow Herd
--	-------------------	------------------	------------------------------

(Average 1930-1932, for Henry, Knox, Peoria, and Stark Counties)

Number of farms.....	33	11	20
Average number of cows in herd.....	11.2	11.7	9.3
Per cent of cattle units that were milked	61.7	12.8	36.9
Pounds of milk per cow milked.....	7251	5956	6084
Pounds of milk per cow in herd.....	6231	1419	3995
Pounds of beef per cow in herd.....	277	745	667
Returns per \$100 worth of feed fed...	\$130	\$71	\$100

(Average 1931-1933, for Grundy, LaSalle, Marshall, Putnam Counties, and Average 1932-34, for Livingston, McLean, Tazewell, and Woodford Counties)

Total number of farms.....	130	17	17
Returns per \$100 worth of feed fed...	\$166	\$76	\$103

* Ill. Agr. Exp. Sta., Bul. 444.

farm-management cost-accounting studies during years when the price of beef was very low, and for this reason may not fairly represent the returns normally to be expected from beef-cow herds and dual-purpose herds. Nevertheless, the data show the relative returns from the three kinds of herds when kept in sections affording general dairy markets, that is, principally the markets that buy cream on a butterfat basis.

3. CHOOSING THE MOST PROFITABLE COWS

By far the most important production factor influencing returns from dairy herds is the amount of milk produced per cow. Many surveys in dairy sections have been made, and further data have been accumulated through cost-accounting studies and dairy-herd-improvement associations. Almost

TABLE VI *
INCREASED YIELD OF BUTTERFAT PER COW MEANS
GREATER POSSIBILITIES OF PROFIT

Yearly Yield of Butterfat per Cow, Pounds	Yearly Feed Cost per Cow †	Feed Cost per Pound Butterfat	Value of Butterfat above or below Feed Cost when the Price of Butter- fat Is			
			20¢ lb.	30¢ lb.	40¢ lb.	50¢ lb.
100	\$47	\$.47	\$-27‡	\$-17‡	\$- 7‡	\$ 3
150	50	.33	-20‡	- 5‡	10	25
200	54	.27	-14‡	6	26	46
250	58	.23	- 8‡	17	42	67
300	62	.21	- 2‡	28	58	88
350	67	.19	3	38	73	108
400	72	.18	8	48	88	128
450	78	.17	12	57	102	147
500	84	.17	16	66	116	166
550	92	.17	18	73	128	183

* Ill. Agr. Exp. Sta., Cir. 440.

† Based on records of cows enrolled in dairy-herd-improvement associations in Illinois during the eight-year period, 1929-1936.

‡ Amount below feed cost.

without exception it has been shown that high-producing cows bring in greater returns over cost of feed than low-producing cows, and this is true for entire herds as well as for individual cows within a herd.

The figures in Table VI show very strikingly the differences in returns above feed cost from cows producing 100 to 550 pounds of butterfat. Feed costs ranged from \$47 per cow to

\$92 per cow for the eight-year period studied. In other words, cows producing 550 pounds of butterfat per cow consumed \$92 worth of feed, or less than twice as much as a cow yielding 100 pounds. The returns above feed cost, however, were vastly different. If the returns are computed at 50 cents a pound of butterfat, a price often received when the product is marketed as whole milk, the cow yielding 100 pounds of butter-



FIG. 6. CHANGING TRANSPORTATION FACILITIES AFFECT THE DAIRY FARMER

Transporting baled hay directly from the farm where it is produced to the barn where it is fed saves much labor in handling as compared with the amount required when hay is shipped in freight cars. Trucks such as these haul 6 to 10 tons in one load. A minimum freight-car load is usually 10 tons. Truck transportation also has greatly changed milk marketing.

fat returned \$3 above feed cost and the cow yielding 550 pounds returned \$183. At lower prices for butterfat, returns were not so great but the relative differences were much the same.

Especially worthy of note is the feed cost per pound of butterfat. It is shown that this was 47 cents per pound for cows yielding 100 pounds of butterfat, but the cost dropped very rapidly with higher production. If the product were to be sold as butterfat at 25 cents a pound, cows producing 200

pounds or less of butterfat could not possibly pay for their feed when feed costs are equal to those shown in Table VI.

Let us consider the returns from cows of average production. During the period covered by these records (Table VI), the average production of cows in the United States and in Illinois was not more than 160 pounds of butterfat per cow annually. By interpolation it is possible to compute that the feed cost for a cow producing 160 pounds of butterfat was about 32



FIG. 7. DOES IT PAY TO MAINTAIN SOIL FERTILITY?

The corn in the foreground is being grown on a check plot which is given **no** soil treatment; that is, no crop residues or fertilizers are applied. Note the stunted growth and also the narrow, rolled leaves indicating that the corn is suffering from lack of moisture. Soil treatment of the plot at the right has induced a luxuriant growth with corn beginning to tassel. Return of crop residues and farm manures increases the water-holding capacity of the soil. Dairy farmers are in a position to maintain soil fertility at high levels.

cents a pound. Under these conditions, therefore, a cow yielding no more than the average production of cows would not return market prices for her feed unless the price of butterfat were 32 cents a pound or more. Even with higher prices for the product, cows of average production give very little return above feed cost to pay for labor, housing, depreciation, taxes, insurance, etc.

Two simple and straightforward conclusions may be drawn from a study of Table VI: first, it is evident that, so long as feed costs remain approximately the same as those in this

table, the possibilities for profit in keeping high-yielding cows are very much greater than in keeping low-yielding cows; second, the lower the price for the product, the greater the possibilities for loss if low-producing cows are kept.

Some dairymen believe that colleges of agriculture are wrong in their advocacy of the keeping of high-producing dairy cows because of the possible creation of a surplus of dairy products. Often a dairy farmer has fixed overhead

TABLE VII *

NUMBER OF COWS OF DIFFERENT PRODUCTIVE LEVELS REQUIRED TO MEET FIXED COSTS

Annual Yield of Butterfat per Cow, Pounds	Value of Product above Feed Cost when Price of Butterfat Is		Number of Cows Needed to Meet Each \$100 of Fixed Costs when Butterfat Sells for		Approximate Amount of Butterfat in Pounds Marketed to Meet Each \$100 of Fixed Costs when Butterfat Sells for	
	30¢ lb.	40¢ lb.	30¢ lb.	40¢ lb.	30¢ lb.	40¢ lb.
150	\$-5	\$10	..	10	....	1500
200	6	26	17	4	3400	800
300	28	58	4	2	1200	600
400	48	88	2	1+	800	450
500	66	116	2	1	800	400

* Based on Table VI.

costs of interest, rent, taxes, labor, etc., that must be met. If milk prices decline, the usual procedure is to buy more cows in order to sell more milk and thus meet the fixed costs. A far better plan would be to increase the production per cow by better feeding and care, combined with better breeding and selection.

The figures in Table VII show the number of cows needed to meet \$100 of fixed costs. It is assumed that these cows (except with the one cow kept at a loss) have already paid for all their feed at market prices and that only the income above feed cost is used to meet the fixed costs. The cow producing 200 pounds of butterfat makes a return of \$6 above

feed cost when butterfat sells for 30 cents a pound. Under these conditions seventeen cows would be needed to meet each \$100 of fixed costs. If Farmer Brown had fixed costs (labor, taxes, etc.), \$600 of which was chargeable to the dairy enterprise, then a herd of 100 cows would be needed to pay for the feed and fixed costs. On the other hand, if cows producing 400 pounds of butterfat per cow were kept, only two cows would be needed to pay \$100 of fixed overhead,



FIG. 8. SEVERE EROSION AND GULLYING MAY FOLLOW DECLINING FERTILITY

This gully was formed in a comparatively level area. The check dam was constructed from stones found in the neighborhood and is held in place by woven wire. Can the gully be filled and the land restored to its original productivity? If so, how many years will be required and what will be the labor cost? Would it not have been cheaper to use good farming methods, such as keeping this area in a good pasture, in order to prevent the formation of the gully?

or 12 cows would pay off the entire \$600 overhead on Farmer Brown's herd. The returns above feed cost of the remaining cows in the herd would be clear profit. It must be kept in mind, also, that on most farms a profit is made when feed is raised and is charged to the dairy herd at market prices.

The figures in Table VII also show the value of high-producing cows in meeting fixed costs and at the same time of preventing surpluses on the market. If cows of a 200-pound butterfat level were kept to pay \$100 of fixed costs (butterfat at 30 cents a pound), the seventeen cows needed would produce

3400 pounds of butterfat; whereas, if cows of a 400-pound productive level were kept, the two cows required would produce only 800 pounds. With higher prices for the product, fewer cows would be needed and there would be smaller differences in the amounts of butterfat marketed.

Two conclusions may be drawn from a study of these figures: first, the higher the production per cow, the smaller the number of cows required to meet fixed overhead costs; second, if high-producing cows are kept, fixed costs are met by a smaller amount of product and there is likely to be less product marketed.

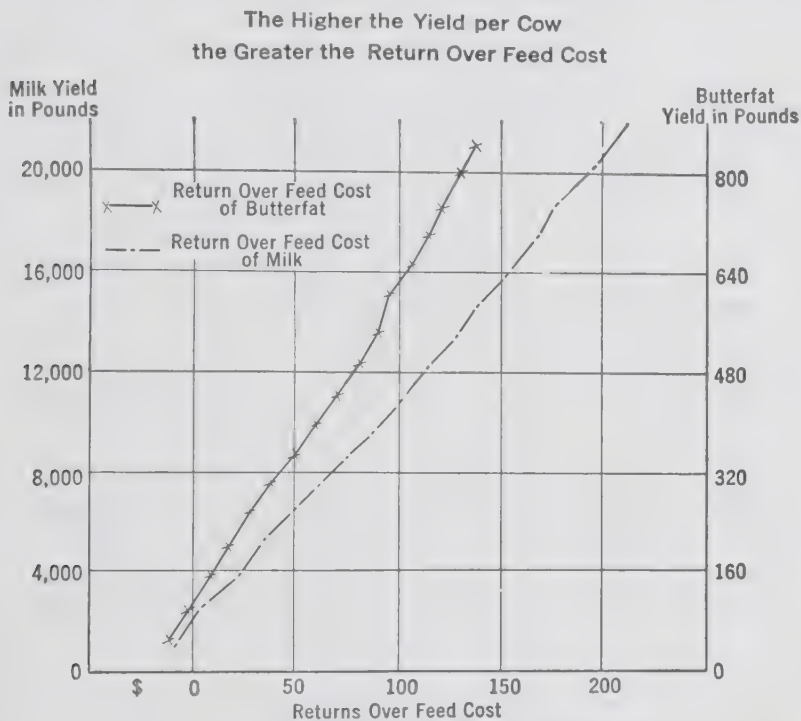
4. STUDYING THE ECONOMY OF HIGH PRODUCTION

Why is it that returns above feed cost increase so much more rapidly than feed cost? For example, it is shown in Table VI that the cost of feed for a cow producing 200 pounds of butterfat was \$54 and for a cow yielding twice that much, or 400 pounds, \$72. This is an increased feed cost of \$18, or one-third. The extra 200 pounds of butterfat were produced at a feed cost of 9 cents a pound. The returns above feed cost (butterfat at 40 cents a pound) increased from \$26 for the 200-pound cow to \$88, or more than three times as much, for the 400-pound cow.

The explanation of these phenomenal differences in the efficiency of individual cows lies in what is termed the economy of high production. The reasons for these differences in efficiency were first fully investigated and explained by the late Professor C. H. Eckles at the Missouri Agricultural Experiment Station. The principles of the economy of high production in dairy cows are defined and explained in the following paragraphs.

The economy, or efficiency, of high production as it applies to dairy cows means that the greater the yield of product by an individual cow, the lower the cost of production for each unit of product. Turning again to Table VI, let us assume that

this table applies to a single cow capable of producing 100 to 550 pounds of butterfat annually, and that her production depends upon the amount she is fed. When fed only enough to produce 100 pounds of butterfat, the feed cost for each unit



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PLATE 1. HIGH PRODUCTION MEANS HIGH NET RETURNS

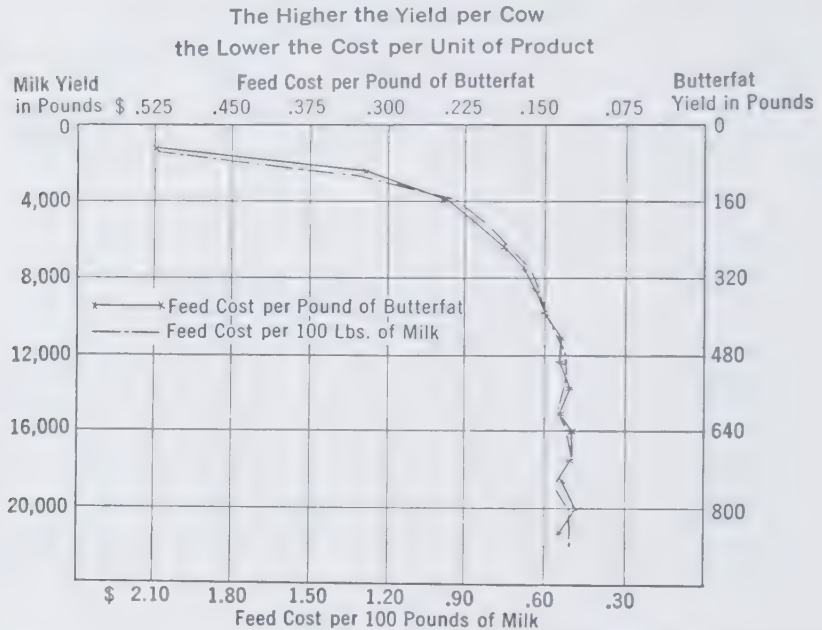
This chart is based on the same records as Plate 2. Although feed costs become greater as production per cow becomes larger, the returns above feed cost increase regularly with each increment of production. Note that the "average" cow of the United States yielding 4500 pounds of milk, returned about \$25 over feed cost, whereas cows yielding three times as much returned more than \$100 over feed cost.

is 47 cents, but when fed enough to produce 550 pounds, the feed cost for each unit is 17 cents.

The explanation involves four factors. First, the amount of feed required to maintain a cow, that is, to keep her at constant weight and in good health, remains practically the

same if she is dry or if she is producing milk. Feed for maintenance, therefore, is in direct proportion to live weight at all times.

Second, after sufficient feed to meet the maintenance needs of a cow has been supplied, the amount of feed required to



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PLATE 2. THE ECONOMY OF HIGH PRODUCTION IS ONE OF THE MOST IMPORTANT PRINCIPLES CONNECTED WITH DAIRY FARMING

The chart, which is based on the records of several thousand cows, shows that as production per cow increases, the feed cost of a pound of butterfat falls from more than 50 cents to less than 15 cents, and the feed cost of 100 pounds of milk declines from more than \$2 per 100 pounds to less than 60 cents. Hence, the conclusion may be drawn that under normal price conditions: "The higher the yield *per cow*, the lower the cost *per unit* of product." This is known as the principle of the economy of high production.

produce a pound of milk of a given butterfat content is practically the same whether the cow is yielding 10 pounds or 50 pounds daily. For example, suppose a cow's maintenance needs are met by feeding her 6 pounds of legume hay and 6 pounds of ground corn, a total of 12 pounds of feed daily. For the production of 18 pounds of milk, 6 pounds of grain

mixture are fed. The total feed, then, is 18 pounds, of which the maintenance feed forms two-thirds. For 36 pounds of milk daily, 12 pounds of grain mixture in addition to the maintenance feed must be supplied. Here the maintenance feed forms only one-half the ration. If the production is increased to 72 pounds daily, the maintenance feed remains the same but the grain mixture is fed at the same rate as before, namely, 1 pound of grain mixture to 3 pounds of milk, and the amount required is 24 pounds. The total feed given daily is now 36 pounds and the maintenance portion forms only

TABLE VIII *
DIGESTIBILITY OF FEED NUTRIENTS BY DAIRY COWS

Number of Cows	Milk Yield Daily per Cow, Pounds	Coefficients of Digestibility of			
		Protein	Nitrogen-free Extract	Ether Extract	Fiber
7	47.7	65.5	78.1	65.4	38.7
4	6.3	66.3	80.1	66.9	34.6
7	0.0	65.5	78.4	63.6	34.9

* Compiled from Ohio Agr. Exp. Sta., Bul. 363.

one-third, whereas two-thirds the feed was used for maintenance when milk production was 18 pounds daily.

A third factor must be considered in explaining the economy of high production. It is frequently assumed by dairy farmers that one of the reasons for the greater efficiency of high-producing cows is that such cows digest a greater percentage of their feed than low-producing cows. Careful investigations have shown the opposite condition to be true; that is, cattle receiving large amounts of feed digest somewhat less of their feed than when they are fed at a lower plane of intake. The differences, however, are small and for practical purposes may be ignored. The figures in Table VIII show very small dif-

ferences in the digestibility of feed nutrients by high-producing cows, low-producing cows, and dry cows. The cows were kept under comparable conditions of feed and care and some were used in two of the groups.

The three factors discussed above explain the part that feed plays in the economy of high production. The principle may be extended to include costs other than feed. The most im-



FIG. 9. LIMESTONE MAKES BETTER FARMING POSSIBLE

A Smith-Hughes teacher of agriculture was largely responsible for the establishment of this limestone crushing plant. It is located in an area where soil fertility has declined to such an extent that corn grown without soil treatment yields only 10 to 20 bushels to the acre, but with a limestone-legume, soil-improvement program crop yields on some farms have been tripled and quadrupled. Trucks haul and spread the limestone on the fields at low cost.

portant of these other costs is labor; but housing, taxes, depreciation, insurance, veterinary fees, etc., are also included. A high-producing cow requires but little more labor and no more barn room than a low-producing one. Depreciation, taxes, insurance, etc., are somewhat greater for high-producing cows. For cows of different levels of production these other costs increase less rapidly than production and it follows, therefore, that they become less and less for each unit of product as production per cow is increased.

5. OBTAINING A HIGH PROPORTION OF PRODUCTIVE UNITS

Not only is it important that all cows in the herd be capable of high production, but it is also essential that the herd be kept in good health and that the breeding records and breeding program be given close supervision so that the cows freshen regularly. Nonbreeding dry cows return no income and the

TABLE IX

RELATION OF PRODUCTION PER COW AND PROPORTION OF COWS MILKED TO RETURNS *

Basis for Grouping Farms	Number of Herds	Average Number of Cows per Herd	Average Yield of Milk per Cow, Pounds	Per Cent of Cattle Units that were Cows Milked	Dairy Returns per 100 Pounds Milk	Returns per \$100 Feed Fed
All Herds Having Highest proportion of cows milked.....	28	11.2	7372	67.5	\$1.24	\$155
Lowest proportion of cows milked.....	28	10.2	7312	50.4	\$1.17	\$125
Highest-producing cows....	28	10.9	8666	64.2	\$1.19	\$156
Lowest-producing cows....	28	10.5	6018	53.7	\$1.17	\$125

* Ill. Agr. Exp. Sta., Bul. 444.

expense of maintaining them is great. As a rule, heifers that are raised for herd replacement should be limited to those of the best breeding. In other words, efforts should be made to have the herd consist of a high proportion of productive units. Records of dairy herds in the counties of central Illinois (Table IX) showed that the herds having the highest proportion of cows milked returned much more per \$100 worth of feed fed than herds in which there was a lower proportion of cows milked.

6. COMBINING GOOD BUSINESS AND GOOD MANAGEMENT PRACTICES

As already pointed out, successful dairy-farm management involves not only good management of the dairy herd but also

TABLE X *

RELATION OF IMPORTANT BUSINESS FACTORS TO LABOR INCOME

	Number of Factors Average or Better					
	None	1	2	3	4	5
Size of business:						
Productive-man-work units.....	523.6	635.2	706.4	779.3	1,172.7	1,148.7
Hundredweight of milk sold.....	1,225	1,447	1,723	2,257	3,740	3,242
Capital employed..	\$12,600	\$15,900	\$17,971	\$21,018	\$30,864	\$28,500
Rates of production:						
Milk produced per cow, cwt.....	60.6	60.8	70.6	78.9	88.5	84.6
Value of dairy products sold per cow	\$133	\$132	\$139	\$163	\$182	\$165
Diversity of business:						
Percentage of receipts from crops	6.7	11.1	17.1	13.9	16.7	21.9
Labor efficiency:						
Tons of milk produced per man..	30.0	32.1	37.8	46.4	55.2	52.3
Efficiency in the use of capital:						
Capital per man...	\$5,676	\$6,419	\$7,008	\$7,811	\$8,083	\$8,301
Receipts per \$100 of capital.....	\$33	\$31	\$36	\$37	\$43	\$43
Financial returns:						
Labor income.....	\$35	\$98	\$794	\$1,360	\$3,387	\$4,202

* Cornell Agr. Exp. Sta., Bul. 696.

the employment of good business practices in connection with the entire farm enterprise. Lack of space prevents a discussion of these business practices here, but examples of their relation to the financial returns of dairy farms are shown in Table X. These data were obtained in Cortland County, New York, on one hundred farms producing Grade A milk.

It is shown in the table, for example, that when two or more business factors were equal to or better than the average of all farms, the milk produced per cow was 70.6 hundredweight; while on farms where five or more business factors were equal to or better than the average, milk yields were 84.6 hundred-



FIG. 10. LEGUMES PROMOTE SOIL IMPROVEMENT

A heavy growth of sweet clover is being plowed under before the bloom stage to provide plant food for a late-planted crop. The sweet clover takes large amounts of nitrogen from the air, and the amount in the soil is increased when the crop is plowed under. The extensive use of legumes for soil improvement, for pasture, for silage, as well as for hay, is one of the important factors which makes possible good returns in modern dairy farming.

weight per cow. Further study of the table shows that the labor income increased rapidly with an increase in the number of factors that were average or better. This increase made possible the selling of more dairy products per cow from the farms having the higher-producing cows. Further, the receipts from crops formed a considerably higher proportion of

the income of the better farms, indicating that farmers with the largest number of factors, that were equal to the average or better than average, had a greater diversity of business and did not depend for their incomes solely upon receipts from milk. The tons of milk produced per man ranged from 30 to 55.2, thus showing wide differences in labor efficiency. More capital was invested per farm and per man on the higher-



FIG. 11. HARVESTING A FIFTH CUTTING OF ALFALFA IN ONE SEASON

An important factor in the improvement of returns from dairy farms is the introduction of new crops and the more extensive use of legumes. In northern states, alfalfa is usually cut for hay only twice during the year, but in regions farther south and in some irrigated sections of the west several cuttings are made. The illustration shows a fifth harvest's being made in Arkansas in October.

income farms and the receipts for each \$100 of capital invested were also greater.

Most striking of all are the financial returns. The labor income in these studies was computed after deducting 5 per cent interest on the capital employed and consisted of "the amount the farm operator receives for his year's work, in addition to the use of a dwelling, to farm products used in the home, and to other privileges which go with the business." The average labor income was \$1049 and the interest \$965, giving an average return per farm of \$2014.

For these groups of farms the labor income ranged from \$35 to \$4202 per farm. Lest it be assumed from these figures that it is easily possible for all farmers to obtain incomes as great as those of the two top groups, it should be noted that these two groups comprised only 14 per cent of the farms. Although all the farms were operated by progressive farmers, the average labor income was only \$1049. The data do show clearly, however, that when a dairy operator succeeded in bringing most of the important business factors to average or better than average, his labor income was far above average.

A further analysis of the data showed the relation of a number of production factors to labor income. It was found that one additional cow contributed an increase of \$42 to the labor income; one additional hundredweight of milk yielded per cow also caused an increase of \$42; one additional point in the crop-yield index effected an increase of \$15; one per cent additional in the percentage of receipts from crops meant an increase of \$51; and one ton more of milk produced per man increased the labor income \$61.

7. DETERMINING THE RELATION OF MARKET PRICES TO RETURNS

The most important factor affecting the income of a particular dairy farm is the market price of the products. As shown in Table VI, the returns above feed cost from a cow yielding 400 pounds of butterfat were \$8 when the price of butterfat was 20 cents a pound, and \$128 when the price was 50 cents a pound. The prices received for milk by members of Illinois dairy-herd-improvement associations from 1925 to 1930 were approximately \$2.45 per hundredweight, and the returns above feed costs were more than \$100 per cow (Table XI). During the years 1931 to 1939, on the other hand, the prices for milk were much lower and the returns above feed cost much less in spite of higher yields and greatly reduced feed costs.

Market prices in some areas may be so low that dairy enterprises are either unprofitable or less profitable than other kinds of farm enterprises. In some localities restrictions of the market are such that it may not be feasible or profitable for a particular farmer to provide facilities or to invest in equip-

TABLE XI *

TRENDS IN PRODUCTION AND RETURNS FROM DAIRY COWS AS SHOWN BY
DAIRY-HERD-IMPROVEMENT-ASSOCIATION WORK IN ILLINOIS

Year	Num- ber of Associa- tions	Num- ber of Mem- bers	Num- ber of Cows Tested	Average Milk Yield, Pounds	Average Butterfat Yield, Pounds	Price per Cwt. of Milk	Average Feed Cost per Cow	Returns above Feed Cost
1925	19	407	11,400	7482	282	\$2.40	\$78.46	\$101.43
1926	25	566	12,198	7566	288	2.48	77.53	110.12
1927	27	597	12,266	7600	289	2.38	73.16	108.01
1928	34	751	15,000	7612	290	2.45	81.82	104.44
1929	49	1072	21,641	7621	300	2.55	81.82	112.58
1930	57	1291	22,000	7895	310	2.43	80.33	111.84
1931	62	1349	26,402	8373	320	1.96	70.10	93.82
1932	54	1076	22,320	8371	318	1.57	51.05	80.14
1933	53	906	20,048	8331	321	1.30	43.42	64.91
1934	51	895	20,424	8470	325	1.43	57.15	63.71
1935	57	965	23,371	8098	312	1.63	68.17	64.01
1936	62	1025	23,812	7980	309	1.76	61.38	79.05
1937	59	1118	25,840	8263	320	1.93	77.99	81.50
1938	65	1273	29,549	8311	322	1.84	65.05	88.16
1939	71	1497	35,377	8345	325	1.60	55.40	78.37

* "A Year's Progress in Dairy Herd Improvement," by C. S. Rhode and J. G. Cash, Agr. Ext. Ser., University of Illinois.

ment that will enable him to fulfill the requirements of that market.

The dairy farmer as an individual has little control over general market prices. He can, however, often obtain better prices by producing a higher-quality product, by cooperative marketing, and by other procedures, as pointed out in Chapter XXII.

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CHAPTER III

SELECTING THE DAIRY COW

Each year with the increase in all forms of herd testing, higher percentages of cows have records of production. Although this trend or tendency does exist, it still is true that a great majority of the cows kept for milk production do not have any record of milk and butterfat yields. In such instances it becomes necessary, if any selection at all is to be made, to choose the animals on the basis of their physical appearance.

It has been demonstrated that there is a definite relation between the form of a cow and her ability to produce milk. To be able, consistently and accurately, to recognize in the individual cow the physical characteristics that indicate her ability to produce large yields of milk is almost a priceless asset to any dairyman. One is able to do this only by careful and close observation of a large number of cows that differ in form and in yield of milk, and thus learn by association to distinguish the characteristics that accompany production capacity.

Operations:

1. Select the right kind of cow.
2. Name the parts of the cow.
3. Choose well-developed capable animals.
4. Choose cows with good dairy tendency.
5. Select for vigor and longevity.
6. Pick out a good roughage eater.
7. Choose cows with well-attached udders of good texture.
8. Select cows that mature slowly and wear well.
9. Whenever possible, use production records to aid in making a selection.

1. SELECT THE RIGHT KIND OF COW

Breeders and dairymen have reached the conclusion that the most profitable cow is one that attains a fairly high level of production and yields essentially at that level year after year for a relatively long life. To accomplish this a cow must possess a certain amount of quality and substance much of which, no doubt, is a heritage that has come to her through her ancestors. In such cases the cow cannot have conspicuous weaknesses that are almost certain, sooner or later, to cause the animal to break down and necessitate her removal from the herd.

Procedure:

- A. Choose cows that calve regularly.
- B. Avoid cows with a tendency to udder trouble.
- C. Avoid cows with crooked legs, open shoulders, and weak constitutions.
- D. Choose for ruggedness and freedom from physical weaknesses.

A. Choose cows that calve regularly. There are wide differences between cows in the regularity with which they produce their calves. Some cows are known as "shy breeders" and such cows are seldom profitable animals.¹ In a study made at the University of Illinois it was observed that cows, although free of disease but with poor calving records, usually continued the same and were not desirable animals in the herd.

B. Avoid cows with a tendency to udder trouble. First-calf heifers with extremely large, highly inflamed udders seldom make good aged or mature cows. Such overdevelopment in a young animal usually causes the udder to become loose in its

¹ It is understood that we are considering here only healthy cows that have been demonstrated by certain specific tests to be free of infectious diseases, and not those that because of such infections abort or have bad calving histories.

attachments to the body. This condition may not appear to be serious at the time; but with further development at subsequent calvings, udders of this type pull away from their attachment to the body of the animal, hang very near the ground, and are subject to injury. Furthermore, such udders are difficult to milk either by hand or with machines.



FIG. 12. JERSEYS BEING OFFICIALLY CLASSIFIED

One of the major activities of the American Jersey Cattle Club is classification based upon individual excellence. It is customary for neighbors and interested spectators to follow the classification.

Udders of poor quality or texture, those that have a high percentage of connective or supporting tissue to secreting tissue, are not only more inclined to injury but also have a greater tendency to mastitis.²

C. Avoid cows with crooked legs, open shoulders, and weak constitutions. These conditions are all evidences of weakness in the animal. They belong to the classification of those

² Any disease or condition that causes the udder to swell up in one or more quarters, any tendency to produce "stringy" or "clotty" milk, or any other disturbance in an udder is usually spoken of as mastitis.

defects that grow worse as the animal advances in age. Some defects, as lack of depth of body, slightly sloping rump in a young or thin animal, or udder somewhat lacking in size in a heifer can and oftentimes do clear up somewhat as the animal matures. Defects to be avoided listed above under C almost always grow worse with age.

D. Choose for ruggedness and freedom from weaknesses. In a study recently made in the Ayrshire breed, it was observed that those cows that produce more than one hundred thousand pounds of milk in their lifetime display unusual stamina and ruggedness. Such cows are highly desirable and usually the most profitable animals in the herd.

2. NAME THE PARTS OF THE COW

In order to draw accurate comparisons or to make contrasts between cows, or even to describe the characteristics of an individual animal, one must discuss the cow one part at a time. At the very outset, therefore, it is necessary to familiarize yourself with the names of these parts. Study Plate III and be able to locate all the parts shown as well as the more common ones which you should already know.

Procedure:

- A. Name and locate all the parts of the head and neck.
- B. Name the parts of the body.
- C. Name and locate the parts of the milking organs.

A. Name and locate all the parts of the head and neck. Locate the muzzle, which is the part above the nostrils and around the lower portion of the face. Identify the poll, the dish in the face, the position of the horns. Observe the relation of the length to the width of the head. Note the length of neck and whether or not the throat is clean-cut.

B. Name the parts of the body. First study the topline and learn to know the difference between the back, loin, and rump regions. Observe the heart girth, or the distance

around the body just back of the shoulders. Note on the chart how much deeper the barrel is in the rear portion than in the front. See if this is true in the animals you study. Note the position of the hooks and pin bones. Observe whether or not the animal stands straight on its hind legs, as does the cow on the chart, or whether there is a greater bend at the

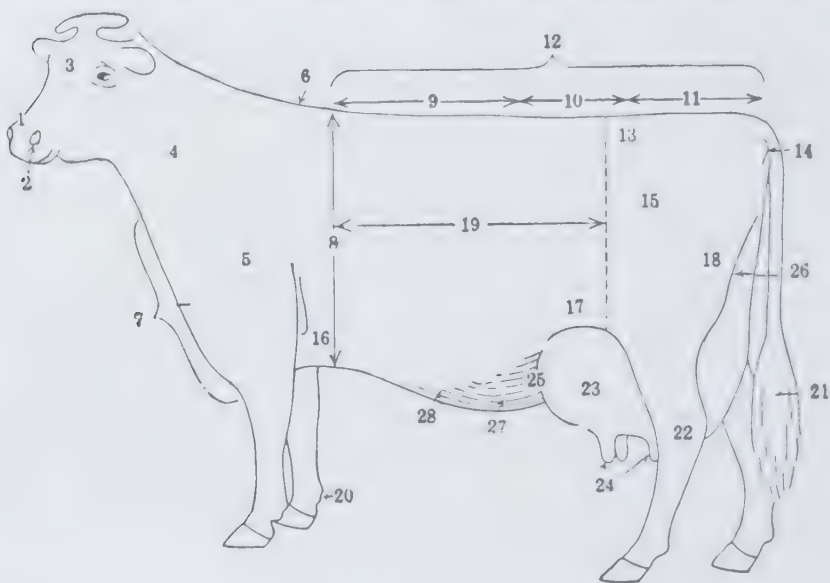


PLATE 3. PARTS OF A DAIRY COW

1. Muzzle; 2. Nostril; 3. Face; 4. Neck; 5. Shoulder; 6. Withers; 7. Dewlap; 8. Heart girth; 9. Back; 10. Loin; 11. Rump; 12. Topline, generally called back; 13. Hooks; 14. Pin bones; 15. Thurl; 16. Elbow; 17. Rear flank; 18. Thigh; 19. Barrel; 20. Dew claws; 21. Switch; 22. Hock; 23. Udder; 24. Teats; 25. Front attachment of udder; 26. Rear attachment of udder; 27. Milk vein; 28. Milk well.

hock (sickle-hocked). When viewed from the rear are the hind legs together at the hocks with feet apart (cow-hocked), or are the legs straight?

C. Name and locate the parts of the milking organs. Observe carefully the udder as it appears on the chart. Compare its size with the size of the entire cow. Make a similar comparison in cows that you study. As you have opportunity to inspect cows, observe the forward and rear attach-

ments of the udder and note the size and location of the teats and the position of the milk veins. Find the milk well by feeling with your index finger at the end of the milk vein.

Characteristics of the good milk cow. The ability to secrete milk is one of the principal characteristics common to mammals. Other characteristics of this order of animals are that they possess hair and bring forth their young alive. The lowest group classed as mammals, the monotremes (wombat and spiny anteater), lay eggs, and nourish their young by the secretion of milk from small rudimentary glands located at the roots of hairs. The young obtain this milk-like material by licking these hairs. The next-higher group is the marsupials, or pouch-bearing forms, of which the kangaroo and opossum are the most common illustrations. The young of the marsupials are born in a very immature state, are put into a pouch by the mother, and derive their nourishment by adhering to rudimentary mammae or teats. From these lower forms we find progressive development until in the cow we have probably the most pronounced and prolonged ability to secrete milk found in any of the mammals.

3. CHOOSE WELL-DEVELOPED CAPABLE ANIMALS

In general, dairy-cattle breeders, other factors remaining the same, prefer well-developed animals that are equal to or above the average of their breed in size. The failure of an animal to grow to proper size may be due to several causes, among them: (1) lack of feed of proper kind and quantity to produce normal growth and development; (2) unfavorable combination of hereditary factors of ancestors; (3) disease and improper management. Calves from stunted parents may be developed to normal size by normal feeding. On the other hand, calves from parents that are small because of undesirable hereditary characters will be likely to remain small no matter how they may be fed.

Procedure:

- A. Estimate the weights of five well-grown and five undersized mature cows.
- B. Measure their height and length of body.
- C. Study your herd or that of a neighbor from the standpoint of the size of the animals.
- D. Determine the average size of mature cows of the different dairy breeds in your community.



FIG. 13. DEMONSTRATING CORRECT FORM IN DAIRY CATTLE

The desirable qualities and the faults are being pointed out to a group of interested breeders.

A. Estimate the weights of five well-grown and five undersized mature cows. Select five cows that are well-grown for their breeds and five that are small. Choose, if possible, cows that are of similar breeding and in approximately the same condition of flesh. Estimate the weights of these cows and then check your estimates with the actual weights of the animals over the scales. If scales are not available, ask a number of farmers or experienced cattle buyers to estimate the weights and take the average of their estimates as the check upon your own. Note the variation between your estimate

and the actual weight or average estimate for each cow. Attempt to determine why your estimates were not in agreement with the actual weights. Profit by this procedure when you again estimate the weight of an animal.

B. Measure their height and length of body. When two animals of the same height and length of body differ in weight, the difference may be due to either of two factors: (1) difference in general form, or (2) difference in condition of flesh. If the cows that you have selected are gentle, measure their heights at the wither. If they are not gentle, measure the height of other cows of different sizes and forms.

In measuring the height at the wither, be sure that the animal is standing squarely on its feet and is in a normal position. Use a standard³ graduated in centimeters or inches, preferably one with an adjustable arm at right angles to the main standard. Place the standard on the ground and perpendicular to it. (Some standards are equipped with a spirit level to aid in keeping the instrument exactly perpendicular.) Lower the adjustable bar until it touches the highest point of the wither of the animal to be measured, and take your readings for height from the under side of the bar on the graduated scale of the standard.

Obtain the length of body by measuring the horizontal distance between shoulder points and pin bones.

C. Study your herd or that of a neighbor from the standpoint of size of animals. Make a comparison between the size of animals in your herd and those of your neighbor. Unless you are interested in some special herd, choose one near by for this study. Are the animals, age considered, larger or smaller than those of other herds? Are they in the same condition of flesh? Does it appear that the difference, if any, is due to feeding or to the hereditary characteristics of the animals?

³A splendid set of measuring instruments can be obtained through Eimer & Amend, Third Ave. and 18th St., New York City. This set includes a caliper and standard similar to those illustrated in Fig. 14.



FIG. 14. MEASURING STANDARD AND CALIPER

These instruments are useful in measuring dairy animals quickly and accurately.

D. Determine the average size of mature cows of the different dairy breeds in your community. Determine the average size of mature cows of all the different breeds in your locality, using the weights and measurements already obtained and making similar studies of the different breeds in your vicinity. Check your findings with the values in Table XII.

TABLE XII
NORMAL SIZE OF DAIRY FEMALES *

Age	Holsteins		Ayrshires		Jerseys	
	Weight, Pounds	Height, Inches	Weight, Pounds	Height, Inches	Weight, Pounds	Height, Inches
At birth.....	90	28.3	69	.....	55	26.0
1 month.....	121	30.2	90	27.5	76	27.7
2 months....	157	32.3	128	29.5	105	29.4
3 months....	200	34.2	170	31.2	140	31.2
4 months....	249	36.2	218	33.1	174	32.9
5 months....	302	38.0	254	35.1	222	35.1
6 months....	349	39.7	286	36.4	260	36.9
9 months....	466	42.9	366	39.0	376	40.5
12 months....	588	44.8	456	40.7	456	42.6
15 months....	612	46.8	547	42.4	520	44.4
18 months....	686	47.9	604	43.7	572	45.5
24 months....	841	49.8	759	45.9	716	47.4
30 months....	1021	51.5	.....	47.2	764	48.3
36 months....	962	52.3	.....	47.9	.....	48.9
48 months....	1065	53.1	917	48.5	854	49.4
60 months....	1140	53.6	960	49.1	.....	.....
72 months....	1220	54.0	1002	.....	897	.....

* Adapted from Brody and Ragsdale, Mo. Agr. Exp. Sta., Res. Bul. 62, 1923.

Are your animals larger or smaller than those given for the breeds which you have studied?

4. CHOOSE COWS WITH GOOD DAIRY TENDENCY

The natural function of milk production in the dairy cow is highly developed. Cows that possess a highly developed dairy tendency will sacrifice, if necessary, their own tissues to produce milk. It has been observed that cows will use up as much as one-fifth or one-sixth of their own tissues (provid-

ing they are in fairly high condition at calving time) in the production of milk. This pronounced disposition to produce milk is termed dairy tendency and contrasts the dairy cow from the beef animal which utilizes its feed for addition to its own tissues. All cows do not possess the quality of dairy tendency to the same degree. The task of the dairyman is, therefore, to be able to distinguish between the cows that are highly developed in this respect and those that are lacking in this quality.

Procedure:

- A. Choose a cow with a clean-cut face and long, slender neck.
- B. Choose a cow with prominent, clear, bright eyes.
- C. Choose a cow that does not carry excess flesh when milking.
- D. Choose a cow with loose, mellow hide.

A. Choose a cow with a clean-cut face and long, slender neck. One of the best evidences of dairy tendency is a lean face and head with clean-cut features. The face in most breeds, especially the Jersey, should show a pronounced dish between the eyes. The jaws should be strong and free from excess flesh. The neck should be long and slender and free from an undue amount of dewlap.

B. Choose a cow with prominent, clear, bright eyes. Select a cow with large, prominent eyes without too much white about the pupil. The look from the eye should be alert, but not show a wild or restless disposition. Dull, half-closed eyes are a sign of sluggishness.

C. Choose a cow that does not carry excess flesh when milking. In picking your dairy cows, pay special attention to the length of time they have been milking. Cows that have calved somewhat recently, that is, from one to eight months, should not be carrying much fat unless they are under very heavy feeding for large records. Cows that do carry excess

flesh when milking are usually deficient in dairy tendency and are for the most part neither heavy nor persistent milkers.

There is a different texture to the flesh that is temporarily stored by the good dairy cow, to be drawn on during her milking period, and that of tissue habitually carried by a cow. The former tissue is soft and spongy and smoothly laid



FIG. 15. A SUPERIOR INDIVIDUAL OF THE JERSEY BREED

This cow has the characteristics most desired in this breed, exceptionally well developed. She is a good type to keep in mind in judging.

on, whereas the latter is harder and is usually put on in patches, especially about the tailhead.

D. Choose a cow with loose, mellow hide. Notice that the hide of a good dairy cow in a healthy working condition is loose and mellow. With the thumb and fingers pick up the skin of a dairy cow just over the last ribs. Draw it gently from the body. Observe how loose and pliable it is. Do the same with a beef animal and note the coarser, heavier hide. The quality of an animal is also noticeable in its hair, the hair of the dairy cow in good condition being soft and neither wiry nor coarse.

5. SELECT FOR VIGOR AND LONGEVITY

We are appreciating more and more the need for placing a proper value upon longevity. Production and cost-accounting records show that a cow must be four and a half or five years old before she pays her owner for the cost of her keep prior to the time she reaches a productive age. In other words,



FIG. 16. A SUPERIOR INDIVIDUAL OF THE HOLSTEIN BREED

This cow is an excellent specimen of the Holstein breed. She conforms to the breed standard for type and has a record of approximately 900 pounds of butterfat.

until a heifer is in production she has no opportunity to supply any income to her owner. Her keep up to that time is wholly an expense. Furthermore, heifers in milk must produce more milk than is necessary to pay all the costs of their current keep before they can begin to repay the owner for his feed and care prior to calving.

A dairy cow in full flow of milk consumes more feed, and therefore transforms the energy of feed into the energy of

milk and other body processes, than does the average draft horse in the same length of time. The conversion of large quantities of feed into milk if continued year after year makes unusual demands upon the constitution of the cow. It is, therefore, highly important to select a cow that is vigorous and gives evidence of possessing a strong constitution.

Procedure:

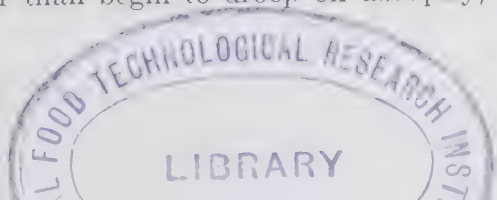
- A. Determine depth and breadth of chest.
- B. Note whether cow has strong head.
- C. See that cow has large, open nostrils.
- D. Make sure that ribs are well sprung.

A. Determine depth and breadth of chest. Stand in front of the animal you are observing and note whether or not she has a broad, full chest with a good width between the front legs. Observe also whether or not the chest is full and well rounded out at the elbows. Look down over the shoulders of the animal and determine the width of the chest and the spring of the upper rib.

B. Note whether cow has strong head. The head of a cow not only is indicative of the quality and dairy tendency of the animal but also bears a relation to her vigor and strength. A face that is strong and broad, especially below the eyes and above the muzzle, is to be desired. Also look for a good depth of jaw and a fairly good width between the jaws.

C. See that cow has large open nostrils. Cows that possess small muzzles, narrow faces, and small nostrils frequently are lacking in constitution and because of that fact do not produce a large quantity of milk. One should select cows that have large, full muzzles and open, flaring nostrils.

D. Make sure that ribs are well sprung. It is not to be expected that the dairy cow will show the extreme spring of rib displayed by the beef animal with its broad, flat back. However, the ribs should start from the spinal column almost at right angles to it, rather than begin to droop off abruptly,



making a narrow animal. Cows with well-sprung ribs, even though they are not so deep in body, usually are more vigorous and many times are more persistent in production than narrow animals.

6. PICK OUT A GOOD ROUGHAGE EATER

Roughage, especially legume roughage, supplies the cheapest digestible nutrients. Nature has endowed the cow with a digestive system well adapted to the storage, use, and digestion of bulky roughages; and if a dairyman is to make the best use of nature's provision, he should take full advantage of the cow's roughage-consuming ability.

All cows are not equally well fitted by nature for this purpose, and the good dairyman judges by the development of certain parts of the cow's body how well she may be expected to utilize large quantities of rough feeds.

In choosing a cow look for the following points to indicate feeding capacity:

Procedure:

- A. Select for a strong muzzle.
- B. Choose cows with long, broad bodies.
- C. Reject cows that are especially deficient in depth of body.
- D. Look for greedy eaters.

A. Select for a strong muzzle. A strong muzzle with full lips shows that the cow is able to consume a large amount of feed.

B. Choose cows with long, broad bodies. Cows are usually longer in body in proportion to their height than bulls. They are also required, because of milk production, to consume a larger amount of feed for a given weight of animal. Observe cows in your herd or vicinity and determine whether or not the long-bodied cows with well-sprung ribs are regarded as the larger eaters.

C. Reject cows that are especially deficient in depth of body. A shallow body usually means that a cow does not have a good constitution and is not able to consume any great amount of feed. In considering this characteristic, however, one should find out how the animal has been fed. Animals which have not received enough feed or those which have been sick may look extremely deficient in depth of body and yet, when in normal condition, may be quite acceptable in that respect. Compare the animal in question with others in the herd. If all are in like condition, the trouble is probably due to lack of feed.

D. Look for greedy eaters. A good appetite is an asset to a dairy cow. Watch several cows while they are eating and note the differences in the way in which they consume their feed. Observe cows at pasture and study their methods of eating. Count the number of bites which several of them take per minute.

7. CHOOSE COWS WITH WELL-ATTACHED UDDERS OF GOOD TEXTURE

Milk is secreted in the udder or mammary gland. It is in the udder that the food materials after having been digested and assimilated by the cow are converted into milk. Perhaps no single part of the cow is so important in determining her milk-producing or her commercial or sale value as the udder. Because of this, much care should be taken in carefully examining the udder. The udder is composed largely of two kinds of tissue. Mammary tissue directly responsible for milk secretion is soft and pliable, highly vascular, and gives an empty udder the soft, spongy feeling when handling. Supporting or connective tissue is firmer, provides the support for the mammary tissue, and when too high a percentage is present gives the udder a hard and rigid texture.



FIG. 17. AVOID POORLY DEVELOPED FORE UDDERS

Some cows have a tendency toward light front quarters. Occasionally fore udders of this kind can be brought to normal production by rubbing and manipulating them just prior to calving.



FIG. 18. AN UNDESIRABLE TYPE OF UDDER

Observe the deep cleft between the two front quarters and the tendency of the udder to break away from the body. Udders of this type are undesirable, subject to injury, and reduce the selling price of the animal.

Procedure:

- A. Choose a cow with medium-sized, well-balanced udder.
- B. See that the udder is held snugly to the body.
- C. Select an udder that is properly shaped.
- D. Examine the udder for texture or quality.
- E. Observe whether teats are well placed and of proper size.
- F. Examine teats for warts, extra openings, or leakage.
- G. Notice development of milk veins and wells.

A. Choose a cow with medium-sized, well-balanced udder.

The size of a cow's udder is somewhat of a measure of the amount of milk which she is producing. If the volume of an udder is determined before milking and again after milking, the difference is approximately equivalent to the amount of milk removed. In the examination of an udder, it is important to know when the animal was last milked, and how much of the size is due to the milk contained and how much to the tissues of the gland itself. Age is also a factor in the development of an udder. Young cows cannot be expected to show the development in this organ found in older animals.

Too large an udder is objectionable, because of the danger of injury. Overdevelopment usually indicates that the gland is not functioning normally. You should be able to distinguish between the extreme distention of the udder, owing to the feverish and swollen condition just before and shortly after calving, and the naturally large gland referred to above. Too small an udder indicates a lack of capacity. Before condemning a cow on this basis, however, it is well to take into consideration the age of the animal and the length of time from calving.

The examination of a large number of cows shows that 55 to 65 per cent of the yield of milk is the product of the two rear quarters. Thirty-five to 45 per cent is produced by the front quarters. Many individual animals show even wider differences than these. A desirable udder is one in which not more than 60 per cent of the milk comes from the rear quarters, or

less than 40 per cent from the front quarters. A greater difference than this usually means that there is an improper balance, or unevenness, in development of the quarters.

B. See that the udder is held snugly to the body. It is important that the udder be attached high and wide at the rear.



FIG. 19. AN UNBALANCED UDDER THAT HANGS LOW

Udders of this type are very much subject to injury, especially just preceding and following calving. Cows with udders of this type seldom live to remain in profitable production after they are six or seven years of age.

When it is so attached there seems to be less tendency for the tissues to relax and permit the udder to break away from the body. Furthermore, an udder with a wide rear attachment is usually wider than one with narrow attachment and so has good capacity without extreme depth. The front attachment

of the udder should be well forward and somewhat wider than the rear attachment. There should be no tendency for a separation between the udder and the body of the animal. The tendency for an udder to "break away" from the body becomes more pronounced with each succeeding lactation.

Figure 19 pictures an empty but pendulous udder, one so pendulous that it is much in danger of injury. Such a condition reduces the productivity as well as the sale value of an animal.

C. Select an udder that is properly shaped. Animals with well-shaped udders are in demand. Figure 25 shows a Jersey cow with an ideally shaped udder. Notice the high rear attachment and the equally balanced rear quarters. Observe also the well-developed front quarters and the snugness with which the udder is held to the body, even though the udder is "bagged"⁴ to its full capacity. Figure 20 also pictures a desirable type of udder. This udder is not distended by bagging but is of normal working size. Figure 17 illustrates an udder deficient in front quarters and lacking proper balance. Another deficiency not uncommonly found is badly divided quarters. This is especially common in the front quarters. Figure 18 gives an idea of such an udder.

D. Examine the udder for texture and quality. The udder is composed of different kinds of tissue, two of which, the secreting tissue and the supporting or connective tissue, predominate. The secreting tissue, as the name indicates, actually secretes the milk. The supporting tissue binds the secreting tissue together and holds it in position. Secreting tissue is soft, flexible, and spongy to the touch, whereas supporting tissue is hard and flesh-like.

It is highly desirable that the udder be of good texture or, in other words, contain a high percentage of secreting tissue. Such an udder is capable of producing more milk per given

⁴ "Bagging" a cow is permitting milk to accumulate in the udder until there is so much distention that every portion of the gland is gorged with milk.



FIG. 20. THE USEFUL AND DESIRABLE TYPE OF UDDER

Note the symmetry and balance as well as the splendid forward attachment of this udder. Good-type cows with udders of this kind are always in demand.



FIG. 21. AN EXCELLENT UDDER OF FINE TEXTURE OR QUALITY

This udder has yielded as much as 135 pounds of milk in one day and over 900 pounds in seven days. Udders of this type are highly prized by dairymen.

unit of tissue than one that possesses a higher proportion of connective tissue. It is almost impossible to judge the texture when an udder is highly distended with milk. When this happens, it will be necessary to remove the milk and examine the empty udder. An udder that collapses when milked out and is loose and pliable when handled is ordinarily one of good texture. Udders that are hard and "meaty" to the touch are often associated with a lack of persistency in the cow.

E. Observe whether teats are well placed and of proper size.

The teats are best located when set at least six inches apart from front to rear and almost an equal distance apart from side to side. Teats that are too close together interfere with the operation of milking. Teats should be large enough to be grasped readily by the hand and yet not so large as to make milking difficult or tiresome for the milker. Teats that are too small make milking somewhat difficult and slow.

F. Examine teats for warts, extra openings, or leakage.

The teat should be smooth and free from warts. If warts are present, they can sometimes be reduced and softened by the application of vaseline or some similar substance. Occasionally there is an extra opening in the side of a teat. Such an opening is undesirable as it tends to soil the milker's hands and to cause a loss of milk. Not infrequently a cow is found in which the sphincter muscle ordinarily closing the opening of the teat does not function normally. The result is that the milk drips, or at times may even run in small streams, from one or more teats. This condition is undesirable even though cows so affected are usually easy milkers. Again, it is not uncommon to find cows in which one or more teats spray milk at the time of milking. Not only is this insanitary and causes a loss of milk but also is likely to soil the clothing of the milker.

G. Notice development of milk veins and wells. Perhaps no two terms are more frequently misunderstood than "milk vein" and "milk well." The name "milk vein" would seem to indicate that the vein contained and carried milk. This is not

true. The milk vein carries blood from the udder toward the heart, for purification, and thus performs the same function as other veins, all of which carry blood. Two milk veins are located on either side of the animal, extending along the underline and lying just beneath the skin. The openings through which these veins enter the body cavity are termed milk wells. Generally there are but two openings, or wells, one on either side. Not infrequently the milk vein separates into a number



FIG. 22. A GUERNSEY UDDER OF GOOD FORM AND TEXTURE

This udder is well-balanced between quarters, has both a good forward and rear attachment, but might be criticized because the rear teats are a trifle short.

of branches, each one of which enters the body cavity through a separate opening. Cases are reported in which as many as thirteen openings, or milk wells, have been observed in a single animal. Figure 21 shows an extreme development of udder and veins. Figure 22 also illustrates large, tortuous veins.

Large milk veins and milk wells are associated with high milk yield. It must be borne in mind, however, that extreme development usually appears in older animals. Large milk



FIG. 23. AN EXCELLENT JERSEY UDDER

This udder represents a desirable type of Jersey udder. It is slightly too long in front attachment and could be improved by a little better size of the rear teats.

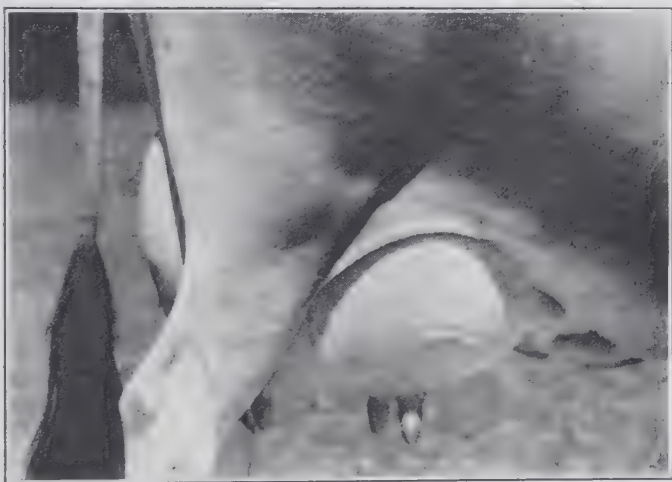


FIG. 24. A VERY GOOD UDDER, EXCELLENT SPACING OF TEATS

Front udders of this type usually are less inclined to break away from the body than are those in Fig. 23.

veins and wells are more an evidence that cows have produced heavily in the past than that they will produce heavily in the future.

8. SELECT COWS THAT MATURE SLOWLY AND WEAR WELL

There is a growing tendency on the part of better breeders to favor animals that produce well over a long span of life. On the average, the receipts from a cow, over and above the costs of production for the first two and one-half years of her productive life are required to equal the cost of rearing the animal to productive age. Stated differently, the animal is four and a half to five years of age before she has paid for her keep and is able to contribute any net profit to her owner. It is assumed here that her calves have no considerable initial value at birth.

Procedure:

- A. Choose animals that appear younger than they are.
- B. Select those that improve in production from first to second and second to third lactations.
- C. Avoid defects that get worse with age.
- D. Pick foundation animals from long-lived families.

A. Choose animals that appear younger than they are. The matter of early maturity in meat-producing animals has received much emphasis. Animals that have the smoothness and finish that the market demands at an early age are usually produced at the lowest cost. Of late years the market has demanded smaller cuts which has meant that animals are marketed at an earlier age.

In dairy cattle, two functions must be emphasized: first, reproduction; and second, milk production. The first of these initiates the second, and the more times the process is repeated in a profitable animal the more desirable the individual. It has been demonstrated that slow-maturing animals, with dense

bone, trim shapely joints, and displaying quality throughout are more likely to stand up well than early-maturing, coarse-boned, puffy-jointed, crooked-legged, and open-shouldered animals.

B. Select those that improve in production from first to second and second to third lactations. It has been observed that the highest-producing cows display the quality not only of improving in production from one lactation to another in their



FIG. 25. AN EXCELLENT JERSEY UDDER

Very high and wide rear attachment, excellent size and spacing of teats, and a very strong front attachment. The cow possessing this udder was almost eleven years old at the time the photograph was taken.

early life but also of sustaining their production over a longer period of time once it is attained. In such animals the highest single lactation record occurs at a later age than is true in average cows.

C. Avoid defects that get worse with age. Defects differ in intensity or amount, they also differ in their reaction to the passing of time. Defects that improve with age may not be defects at all in the sense that they persist throughout the life of the animal. They may be corrected or they may correct

TABLE XIII

LONGEVITY IN DAIRY CATTLE

(Three Oldest Cows of Each Breed)

Name of Animal	Age at Last Calving Years and Months
<i>Ayrshire</i>	
1. Victoria	23 yrs., 2 mo.
2. Oak Valley Coming Queen 56675	19 " 0 " *
3. Oak Valley Stockwood Queen 56674	18 " 9 "
<i>Brown Swiss</i>	
(Information Not Available)	
<i>Guernsey</i>	
1. Sunderland's Gertrude of Lawnsdale 56292	20 yrs., 4 mo.
2. Anna Lee of Hickory Ridge 61887	20 " 0 " *
3. Alice's Queen 66624	20 " 0 " *
<i>Holstein-Friesian</i>	
1. Ana Clothilde 25384	21 yrs., 8 mo.
2. Daisy Nevius DeKol 651804	19 " 2 "
3. Gerben Parthenea Piebe DeKol 3d 292547	18 " 8 "
<i>Jersey</i>	
1. Cassie of Far View 502144	19 yrs., 9 mo.
2. Imp. Broadlands Lady	18 " 0 " *
3. Little Queen's Buttercup 546936	18 " 0 " *

* Months unknown.

themselves. Other defects get worse as the animal gets older. Examples of this type of defect are low back, crooked hind legs, open shoulders, loosely attached udders, bad feet, long large teats, etc. Avoid such defects and do not select breeding animals from parents with these defects when they are bad enough to interfere with the function of the animal.

D. Pick foundation animals from long-lived families. The qualities mentioned in paragraphs A, B, and C are in large part hereditary. It is a good practice to select breeding animals from families that do not possess such defects. Long-lived families are most likely to be free of such defects otherwise they would never have attained advanced age. The preceding table indicates the age of last calving of the oldest animals of the several breeds that the authors have been able to confirm.

9. WHEN POSSIBLE USE PRODUCTION RECORDS TO AID IN MAKING SELECTIONS

Make it a point to obtain all the evidence possible when selecting milking animals. Authentic production records present proof of productive capacity though it must be kept in mind that the conditions under which the records are made are important factors in determining the size of the record. Such factors or variables as age, number of milkings per day, per cent fat content of the milk, whether or not the animal carried a calf during the major part of the lactation are all factors to consider. Of these, age at calving is the most important.

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CHAPTER IV

CHOOSING A BREED

One of the questions most frequently asked in correspondence received by departments of dairy husbandry is, "Which is the best breed of dairy cattle?" The answer to that question cannot be made intelligently until all the facts regarding the market, the climatic conditions, systems of management, and local surroundings are available. Even then it must be fully realized that inferior animals of one breed cannot compete on equal terms with superior animals of another breed even though the superior breed is not so well endowed by nature for the conditions and market in question.

In choosing a breed it is highly important that one familiarize himself with the characteristics of the different breeds, and fortified by that information he is in a better position to make an intelligent choice. The discussion here given is intended to present various factors that should be considered before making a final choice of a dairy breed.

Factors determining choice:

1. Characteristics of the major breeds of dairy cattle.
2. Community preference.
3. Adaptation to climate and environment.
4. Adaptation to market.
5. Personal preference.

1. CHARACTERISTICS OF THE MAJOR BREEDS OF DAIRY CATTLE

Although the different breeds of dairy cattle originated from essentially the same ancestors by virtue of their various locations and different types of selection, rather wide differences now exist between the breeds in many of their characteristics.

It is important for the breeder of dairy cattle, and certainly for the student in dairying, to know these differences and their significance.

Procedure:

- A. Identify breeds by color.
- B. Note their size and type.
- C. Learn something of their beef value.
- D. Observe their characteristics in production.
- E. Consider adaptability to special markets.
- F. Study their native home and early environment.
- G. Name and locate breed associations for each breed.
- H. Note the qualities of dual-purpose cattle.

A. Identify breeds by color. Three of the major breeds of dairy cattle are naturally spotted. These are the Holstein, Guernsey, and Ayrshire, the Holstein being black-and-white spotted with a definite line of demarcation between the black and the white. Occasionally animals of this breed have small irregular spots, but usually the spots are fairly large and the separation distinct. Occasionally in the older animals there will be a graying appearance, particularly about the head, neck, and over the shoulders. When this takes place, the animals may become quite grayish in appearance. This is somewhat objectionable, but does not bar the animal from record unless it occurs at an early age and is quite marked.

The Guernsey is of a lemon or orange-fawn color, occasionally approaching red, with white markings. The line of demarcation between the fawn and the white is usually distinct. Guernseys are also characterized by a buff-colored muzzle and pinkish pigmentation around the eyes and on the unhaired portions of the body.

The Ayrshire, the third of the naturally spotted breeds, has varying shades of red, approaching in some instances almost black, and white. With the Ayrshire the spots are usually indistinct, and sometimes the line of separation be-

tween the colored and white portions is irregular and somewhat splashed in appearance.

The Jersey is usually solid color, varying from a lightish fawn to black. Occasionally spotting occurs in this breed, and then the animal may have varying amounts of white with the body color whatever it may be. For the most part, Jerseys have dark-colored muzzles and dark pigmentation around the



FIG. 26. A SUPERIOR COW OF THE GUERNSEY BREED

This cow represents an excellent individual, a highly prized specimen of the breed. She sold at auction for one of the highest prices ever paid for a Guernsey cow.

eyes and unhaired portions of the body. Occasionally the tongue and switch of spotted animals are light in color. Very rarely do we find a buff-colored muzzle or a light flesh-colored pigmentation about the eyes.

The Brown Swiss breed is usually solid colored with black switch and dark muzzle. The basic color may vary from a light fawn or mouse color to quite a deep fawn or brownish

red. If there is white on the body, it is usually on the underline and on the rear flank. There is quite frequently a lighter-colored band around the muzzle and occasionally a lighter strip down the back of the animal.

B. Note their size and type. The breeds of dairy cattle are usually ranked in size in the following order: Holstein, Brown Swiss, Ayrshire, Guernsey, and Jersey. There is, however, considerable variation between the size of the animals of the different breeds in different sections of the country. The Holstein, for instance, is a little smaller in the eastern part of the United States than it is in the central and western states. In fact, animals of the Brown Swiss breed in the central-western area where they are found in the largest numbers, notably in the states of Wisconsin, Illinois, Iowa, and Minnesota, are frequently heavier than some of the Holsteins found in the New England states. Not only is there considerable difference in the size of the animals themselves, but there is also a difference in the size of their calves at birth. This difference is quite well illustrated in Table 15. This difference in size of the offspring affects the ability of the calves to resist low temperatures and unfavorable conditions, the larger calves usually being better able to survive under an unfavorable environment.

There is considerable variation in the types of the different breeds and almost as much variation among the individuals within a breed. The illustrations showing the different breeds, if studied, will give the qualities of the superior animals of the breed and serve as the basis for a visualization of a standard of excellence.

C. Learn something of their beef value. There is some difference of opinion with regard to the beef value of the different breeds of dairy cattle. Naturally, the beef value of a dairy animal, just the same as a beef animal, depends to a considerable degree upon its condition. In high condition, the Ayrshire probably will kill out the best carcass of any of the breeds of dairy cattle, but the Brown Swiss and the Holstein,

because of their size, are highly prized for their beef qualities.

The Guernsey and the Jersey rank easily at the bottom of the list, first, because of their lack of size and smoothness, and second, because the fat is decidedly yellowish in color, which tends to identify the carcass in the market.

The veal is highly prized and rated superior from the Brown Swiss and the Holstein breeds, with the Ayrshire following as



FIG. 27. A SUPERIOR COW OF THE AYRSHIRE BREED

This cow possesses many of the characteristics most prized by Ayrshire breeders. She has refinement and quality coupled with capacity.

a fairly close third. Guernsey and Jersey calves are usually too small and too poorly fleshed to be prized for veal.

D. Observe their characteristics in production. In milk yield the Holstein is rated first in rank, followed by the Brown Swiss, Ayrshire, Guernsey, and Jersey, in essentially that order. It must be borne in mind, however, that there is a large amount of variability in the yield of different animals within

a breed, and individuals even of the Jersey breed that are decidedly superior in productive capacity might produce more than low-yielding individuals of the Holstein breed. The ratings given are based, therefore, upon general averages for the breeds.

In percentage of fat content, the order is almost reversed, with the Jersey ranking first, followed by the Guernsey, with



FIG. 28. A SUPERIOR AYRSHIRE BULL. ONE OF THE ARISTOCRATS OF THE SHOW RING

This bull was Grand Champion of the National Dairy Show and is a bull of substance, quality, and refinement.

the Ayrshire and Brown Swiss essentially the same, and the Holstein the lowest. Table XIV compares certain characteristics of the different breeds.

These differences in yield and quality of milk are important factors in determining the breed that is best suited for a particular market.

E. Consider adaptability to special markets. There is a growing tendency to take advantage of breed characters in developing special markets for their products. Jersey Cream-line milk is sold in markets where a high fat test is appreciated. Similarly, Golden Guernsey milk sells under a label that identifies its rich yellow color and also its high-percentage fat content. The lower-percentage fat of the Holsteins is

TABLE XIV

CHARACTERISTICS OF THE FIVE MAJOR BREEDS OF DAIRY CATTLE

Characteristic	Ayrshire	Brown Swiss	Guernsey	Holstein-Friesian	Jersey
Place of origin.....	Scotland	Switzerland	Guernsey Isle	Holland and Friesland	Jersey Isle
Rank in size.....	3	2	4	1	5
Approximate number of recorded animals, 1940....	73,500	50,250	243,750	527,850	299,000
Desirable milkyield, pounds	7,500	8,250	6,250	9,500	5,800
Average per cent fat content of milk.....	4.00	4.00	5.00	3.45	5.40
Desirable size mature bulls.	1850	2050	1650	2250	1450
Desirable age at first calving.....	26-28 Mo.	30-34 Mo.	25-27 Mo.	27-30 Mo.	23-25 Mo.
Date present registry association established.....	1863	1888	1877	1885	1868

sometimes taken advantage of in special baby milk. The milk of the Ayrshire, because of its well-balanced composition, is frequently considered desirable for patients in hospitals and sanitariums. Although these special markets utilize a very small percentage of the total production of the breeds, they have considerable advertising value and do aid the individual breeder in marketing his product.

F. Study their native home and early environment. The Ayrshire breed of dairy cattle originated in the county of Ayr in southwestern Scotland. It is one of the newest in point of origin of the breeds of dairy cattle. The Ayrshire, having

originated in a rather rugged country, has developed as a good grazing breed and is highly prized in hilly regions for that characteristic. When this breed was first imported into the United States is a somewhat debated question. Some maintain that the first importation to be kept pure originated in 1822; others hold that the first successful importation came over in 1837.

The Brown Swiss originated in the canton of Schwyz in Switzerland and constitutes one of the two oldest breeds of dairy cattle in point of origin. The Swiss breed has for the most part been developed in the mountainous regions of Switzerland, spending its summers in the highlands and winters in the lowlands. The breed is rugged and seems well adapted to those regions where there is an inclination to transfer from beef to dairy cattle. The first successful importation was in 1869.

The Guernsey originated on the Island of Guernsey, located in the English Channel. This island is small in size, comprising approximately 16,000 acres of which approximately three-fourths is tillable. The cattle are almost without exception tethered or tied at pasture. The first importation to this country was made in 1830.

The Holstein-Friesian breed was developed in the former Kingdom of the Netherlands and is well represented in Holland and Friesland. In respect to origin it is approximately as old as the Swiss, and records indicate the presence of animals of this breed as early as 350 B.C. The breed developed in a country with fertile soils and luxuriant vegetation. The breed is, therefore, well suited to conditions where good pastures and plenty of supplementary feeds are available. The breed was first imported to this country in 1861.

The Jersey breed originated on the Island of Jersey, consisting in area of approximately 36,680 acres, not more than two-thirds of the area being tillable. In its native home, this breed was developed to supply a critical group of breeders who wanted an animal of unusual beauty and refinement. In

this country it has developed into a somewhat larger animal and one well adapted to the warmer climates in the southern states. The breed was first imported into the United States in 1850.

G. Name and locate breed associations for each breed. Each breed of dairy cattle is sponsored by an organization founded and designed to be of service to a particular breed. Breed asso-

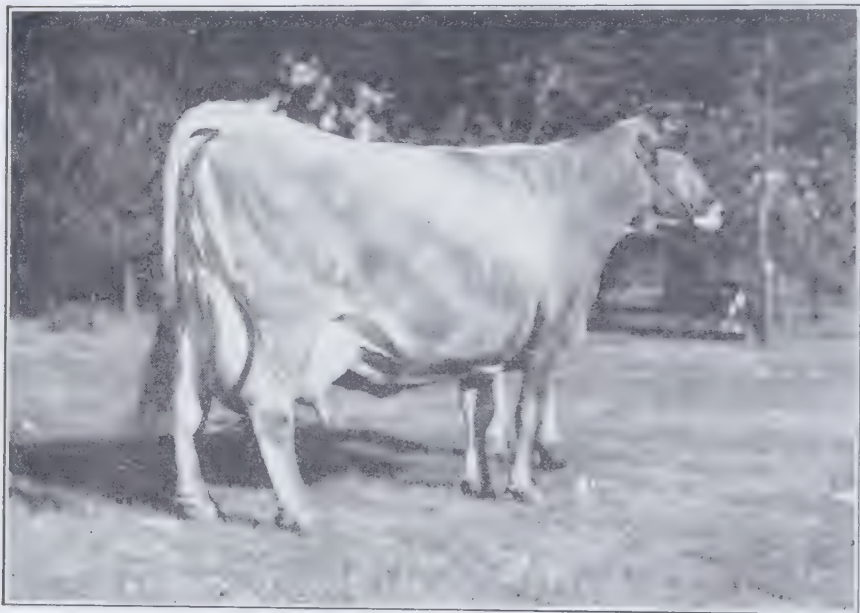


FIG. 29. A SUPERIOR COW OF THE BROWN SWISS BREED

This cow possesses the size and ruggedness desired by Swiss breeders and, in addition, has excellent quality and refinement. She made the world record of the breed for production of both milk and fat, and was Reserve Grand Champion at the National Dairy Show.

ciations support the interest in their breed, have charge of registering the purebred animals, and have general supervision over the testing of such animals for production records.

The Ayrshire Breeders' Association, established in 1863, is located at Brandon, Vermont.

The Brown Swiss Breeders' Association, established in 1888, has its headquarters at Beloit, Wisconsin.

The American Guernsey Cattle Club was established in 1877, with headquarters in Peterborough, New Hampshire.

The present Holstein-Friesian Association, established in 1885, was formed by a union of the Holstein Herdbook Association, organized in 1873, and the Dutch Friesian Association, founded in 1882. This association has headquarters at Brattleboro, Vermont.

The American Jersey Cattle Club was founded in 1868, and is located at 324 W. 23rd St., New York City.

H. Note the qualities of dual-purpose cattle. There are several breeds of cattle sometimes characterized as dual purpose. This term is used to designate those breeds of cattle which are intended for both beef and dairy purposes. In such cases the animals are usually expected to give a reasonably large quantity of milk soon after calving, and during that period are maintained as dairy animals. They are also expected to fatten up readily during the dry period, at which time they are somewhat characteristic of the beef form. Such breeds have a relatively definite place in agricultural production. Of the dual-purpose type, perhaps the Shorthorn is the best known. This breed has been developed in two general directions. One has been for the production of beef, the other has been for milk production. In England the breed has been extensively developed for this dual purpose. In the United States the beef function has predominated, but more recently milking Shorthorns have been gaining prominence, and it is quite likely that they will be classified as a dairy breed in most of the important shows within the next few years. The milking Shorthorn is characterized by a liberal flow of milk for several months after calving and possesses, in addition, the ability to fatten up readily and to go on to the market as an acceptable beef animal.

Red Polls originated in the eastern part of England, probably in the Counties of Norfolk and Suffolk. They have also been classed as dual purpose. They do not have quite the milk-producing ability of the dairy Shorthorn and, in general,

probably are not so popular in the United States. They are smaller than the Shorthorn in size, red in color, and are rather inclined more toward beef form than toward milk production.

The Devon, the Dutch Belted, and French Canadian might also be included in the dual-purpose class. Other breeds, some quite well known in their native country for their dairy qualities, are Dexter, Kerry, Simmenthal, Jutland, Friberg, and Red Danish.

2. COMMUNITY PREFERENCE

Many advantages may be had by choosing the breed of cattle that predominates in the community, unless there be a definite reason for doing otherwise.

Procedure:

- A. Determine which breed predominates in the community.
- B. Determine whether or not breeders are satisfied with their breed of cattle.
- C. Find length of time breeds have been kept.
- D. Determine breed kept by most progressive dairymen.

A. Determine which breed predominates in the community. Make a survey of the farms in your community or township in order to determine the breed of dairy cattle most commonly found. List animals under the following headings: Holstein; Jersey; Guernsey; Ayrshire; Milking Shorthorn; and Native Stock. The last-named class should include all animals that apparently do not belong to any of the other groups. Where there are mixed herds, list animals separately by breeds. When animals are purebred and registered, so indicate by the initials P.B.

B. Determine whether or not breeders are satisfied with their breed of cattle. In making your survey, learn, if possible, whether or not the breeders are satisfied with the production and characteristics of their cattle. Make a list of

the criticisms, both favorable and unfavorable, that you obtain. Ask the dairymen what breed of cattle they would choose if they were again starting in the business.

C. Find length of time breeds have been kept. Find out, if possible, the approximate date of the establishment of the different breeds in your community. Discuss with the older



FIG. 30. A SUPERIOR BROWN SWISS BULL

This bull possesses the ruggedness and substance that Brown Swiss breeders are striving to develop, but also has excellent conformation and good quality. He was Grand Champion at the National Dairy Show and is recognized as one of the outstanding bulls of the breed.

dairymen the order in which different breeds were introduced and the reasons for their introduction.

D. Determine breed kept by most progressive dairymen. One of the best guides in agriculture is afforded by the practices of the most progressive and successful farmers in the community. It is good judgment, therefore, to consider carefully the breeds selected by the most successful dairymen and their methods in handling them.

3. ADAPTATION TO CLIMATE AND ENVIRONMENT

Extremely cold and extremely hot climates are alike unfavorable for the production of milk, unless some special provision is made to keep the cows more comfortable than they normally would be. The breeds react differently to extremes in climate. It is therefore important to know climatic conditions before choosing a breed.

Other factors in selecting a breed are the kind of care and the housing you will be able to give your cattle. Some breeds are larger and more vigorous than others. Their calves are stronger and less subject to disease, or have more resistance when disease is contracted, than the calves of other breeds. Such breeds are able to develop under conditions which would be unfavorable for other breeds.

Procedure:

- A. Find mean temperature for winter and summer.
- B. Determine annual rainfall and abundance of feed and pasture.
- C. Consider the sort of care the herd can be given.

A. Find mean temperature for winter and summer. Consult weather reports and records for your locality or for some city near by. If you live in the southern states you will find the summers more or less unfavorable to the larger breeds, notably Holsteins. On the other hand, if you are located in the northern states, you will find the larger breeds seem to thrive best. Where the climate is not extreme, little attention need be given this factor.

B. Determine annual rainfall and abundance of feed and pasture. While looking up the temperature records, learn also the annual rainfall and the period of the year when the moisture is greatest. While the influence of rainfall on dairying is indirect, it is important in that it affects pastures and crops, especially hays, on which the industry is dependent. Where roughages are plentiful, the larger breeds, like Holstein and Brown Swiss, thrive especially well and so are greatly favored.

Where there is a deficiency of these feeds, the smaller breeds, like Jersey and Guernsey, are more generally found.

C. Consider the sort of care the herd can be given. Some breeds of cattle, as Ayrshire and Brown Swiss, seem to be able to withstand poor shelter and lack of care better than others. Furthermore, the calves of some breeds are larger and seemingly more vigorous than those of other breeds. Generally

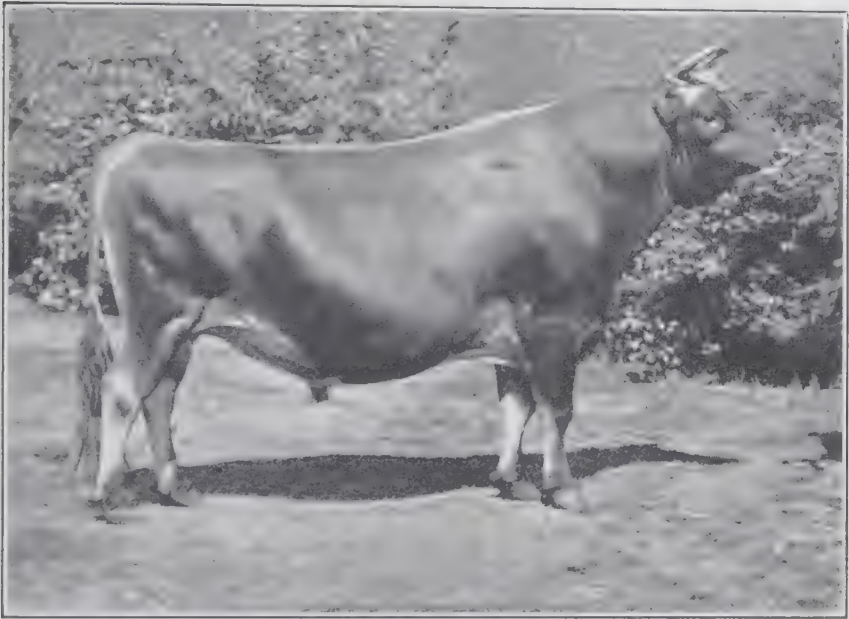


FIG. 31. A SUPERIOR BULL OF THE JERSEY BREED

This bull was considered one of the best types of bull of his breed, large in size, and impressive in appearance. He represents one of the most perfect specimens of the breeder's art. He was Grand Champion at the National Dairy Show for three consecutive years.

speaking, the larger the calves are at birth the more resistant they are to disease and unfavorable conditions. Table XV shows the average birth weights of calves of the different breeds of dairy cattle as well as the ratio of that weight to the weight of the mother.

If you are intending to care for the dairy herd yourself or to give it your personal supervision, very little attention need

be paid to the ability of the breed to withstand poor care. If you are entrusting the herd to indifferent employees, give these facts some consideration.

TABLE XV *
BIRTH WEIGHTS OF CALVES OF THE DAIRY BREEDS

Breed	Number of Calves	Average Weight, Pounds	Average Weight of Dams, Pounds	Per Cent of Dam's Weight
Jersey.....	253	55	867	6.35
Holstein.....	229	89	1137	7.83
Guernsey.....	57	71	996	7.03
Ayrshire.....	80	72	983	6.41
Brown Swiss.....	5	100	1123	8.90

* Eckles, C. H., Mo. Agr. Exp. Sta., Res. Bul. 35, 1919.

4. ADAPTATION TO MARKET

Perhaps no single factor is so important in deciding whether this breed or that shall be chosen as the local market for dairy products. Where a given type of market prevails, the breed best adapted to the demands of that market is usually found. This ordinarily means that the breeds tend to be segregated, one breed being especially numerous where whole milk is produced and sold, and another where there is a market for cream. In selecting a breed, therefore, a study should be made of the available markets in the community and of the breeds that are best adapted to supply those markets.

Procedure:

- A. Find whether or not whole milk is sold, and if so for what purpose.
- B. Determine if cream is the principal product marketed.

- C. Determine whether or not hogs are extensively and profitably raised.
- D. Investigate special markets.

A. Find whether or not whole milk is sold, and if so for what purpose. In sections near our larger cities, almost all the milk produced is marketed in the form of whole milk. The same is more or less true in the vicinity of cheese factories or



FIG. 32. A SUPERIOR GUERNSEY BULL

A Guernsey bull with plenty of scale, yet showing excellent dairy quality and refinement. He was the Grand Champion on many occasions, taking that honor at the National Dairy Show.

condenseries. Where such markets prevail, the higher-yielding breeds predominate, particularly the Holstein. In these regions the farm operations are centered around dairying, the enterprise that brings in the largest part of the farm income.

B. Determine if cream is the principal product marketed. In sections somewhat removed from our larger cities, and from cheese factories or condenseries, cream or butterfat pro-

duction is the main dairy enterprise. In such regions the herds are usually small, dairying being only a side line, subordinate to other farm operations and bringing in only a minor part of the farm receipts. Cows giving milk containing a high percentage of fat are usually favored in these sections where cream is marketed. Except in certain northern states, Jerseys predominate for this type of market.



FIG. 33. A SUPERIOR HOLSTEIN BULL

This bull has demonstrated his quality in the breeding herd and in the show ring, an excellent sire of quality animals, as well as Grand Champion at many leading shows.

C. Determine whether or not hogs are extensively and profitably raised. When butterfat is marketed, skim milk remains as a by-product on the farm. Its principal use lies in livestock feeding, particularly for calves, hogs, and poultry. While part of it is generally used for calf feeding, the largest portion is usually available for hog or poultry feeding. One hundred pounds of skim milk for hog-feeding purposes is considered equivalent in value to one-half bushel of corn. When

corn sells at one dollar per bushel, skim milk is considered worth 50 cents per hundred pounds. In feeding for special purposes, such as fitting hogs for show or exhibition, skim milk has a still higher value. Where there is this profitable use for skim milk, the higher-yielding breeds may be favored rather than the breeds giving the highest yield in butterfat.

D. Investigate special markets. Occasionally there are opportunities to supply a product to a special or select market. For instance, a demand may be created for the retail sale of a special milk for babies or for unusually rich milk. It is sometimes possible to sell sweet cream for ice cream or for some other special purpose.

TABLE XVI

LIVE WEIGHT AND PRODUCTION OF COWS OF THE DAIRY BREEDS

Breed	Average Live Weight, Pounds	Average Yearly Milk Yield, Pounds	Average Per Cent-age Fat in Milk, Per Cent	Source of Data
Holstein.....	....	7,218	3.54	2773 cow-testing association records *
Holstein.....	....	14,887	3.41	5266 advanced-register records *
Holstein.....	1225	14,712	3.43	148 Wis. cow-competition records †
Jersey.....	....	5,364	5.14	970 cow-testing association records *
Jersey.....	....	8,005	5.41	8038 Register of Merit records *
Jersey.....	909	7,063	5.15	76 Wis. cow-competition records †
Guernsey....	....	8,644	5.03	3564 advanced-register records *
Guernsey....	987	8,549	4.98	141 Wis. cow-competition records †
Ayrshire....	....	9,417	3.93	1091 advanced-register records *
Ayrshire....	1031	6,070	3.99	9 cows, 24 lactations, University of Ill. herd *
Brown Swiss.	....	11,281	4.00	311 Register of Production records *
Brown Swiss.	1100-1200			

* Ill. Agr. Exp. Sta., Bul. 245.

† Wis. Agr. Exp. Sta., Res. Bul. 26.

Determine which of the dairymen in your locality market their milk or cream in some special way. Compare the prices which they receive with those prevailing in the general market. Study the advantages and disadvantages of marketing in this

way, and conclude whether or not all breeds of dairy cattle are equally well suited to production for that market.

5. PERSONAL PREFERENCE

Some dairymen dislike the appearance of a Holstein but develop a great fondness for a Jersey. Others admire the ruggedness and large frame of the Holstein but have a great aversion to the smaller and more refined Jersey. Tastes differ in cattle as they do in clothes, and as the possession of a particular breed may mean much to the pleasure of the owner, he should give consideration to the breed of his fancy. It must be remembered, however, that in the long run beauty will not wear so well as utility.

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CHAPTER V

DETERMINING MILK AND BUTTERFAT YIELDS

Keeping records of production is one of the most important of all operations connected with the management of the dairy herd. It is only through a knowledge of the production of each cow that intelligent herd improvement can be carried out. In order to build up the herd, daughters of the best-producing cows must be selected for herd replacements. Then, too, the milk- and butterfat-transmitting ability of a sire is best learned by comparing the production of his daughters with that of their dams.

It is desirable that the percentage fat content (test) of the milk be known as well as the amount of milk produced. Of these two phases of record keeping, a record of the milk yield is far more important than a record of the test of the milk because milk yields of cows differ greatly. The tests of the milk of high-grade and purebred cows of a dairy breed conform rather closely to the average for that breed and vary among individuals far less than do the milk yields. Whenever possible, therefore, records of both milk yields and tests should be obtained, but if only one can be secured, it should be the milk yield.

The records may be obtained through the work of the herdsman, or the farm operator may become a member of a dairy-herd improvement association and thus obtain the services of a paid tester. Owners of registered dairy cattle may arrange to have records of production confirmed and published by the breed association in charge of the registration of his cattle.

Operations:

1. Keeping milk-production records.
2. Sampling milk for butterfat tests.

3. Testing milk for butterfat.
4. Calculating butterfat yields.
5. Determining milk and butterfat yields through the agency of a dairy-herd improvement association.
6. Making advanced registry records.

1. KEEPING MILK-PRODUCTION RECORDS

The total monthly or yearly production of each cow may be calculated and recorded with the aid of the simple equipment described below:

Procedure:

- A. Provide milk-record blanks and scale for weighing milk.
- B. Arrange convenient place for weighing.
- C. Weigh milk from each cow regularly.
- D. Compute milk production for month and year.

A. Provide milk-record blanks. Obtain a supply of blanks from a firm offering them for sale, or rule some sheets of heavy paper about 12 by 24 inches in size. A sheet for recording two milkings daily for one month is convenient for most herds, but forms may also be purchased for recording three or four milkings daily.

Obtain a small scale having a capacity of 30 to 60 pounds. A scale having two adjustable hands is especially desirable for weighing milk. By setting one hand at zero when the empty pail is hung on the scale, the weight of the milk may be read directly when the filled pail is weighed.

B. Arrange convenient place for weighing. The milk-record blanks and the scale should be kept in the room where the milk is strained or emptied from the milk pails. The record blank may be placed in a specially designed case equipped with a glass front having a narrow slot through which the entries may be made. If a case is not available, the record blank may be thumbtacked to the wall and two

pieces of celluloid or cellophane thumbtacked over it, one piece over the upper part and the other over the lower, these pieces being moved every day so that all the sheet except the lines for one day's entries are covered. The object of the transparent covering is to prevent soiling of the record by hands or flies. The scale should be near enough to the milk-record sheet to be read while the weight is being recorded.

C. Weigh milk from each cow regularly. If possible, weigh and record the milk from each cow at each milking. When time does not permit this, weigh the milk from each cow on a certain day of each week, or on the first three days of each month. When milk is not weighed every day, note on the milk sheet the date when any cow is turned dry.

There are a number of advantages in weighing the milk produced by each cow, aside from the fact that this enables the herdsman to compute each cow's total production. Economy in feeding can be secured only when a milk record is available as a guide to the amount to be fed. Daily weigh-

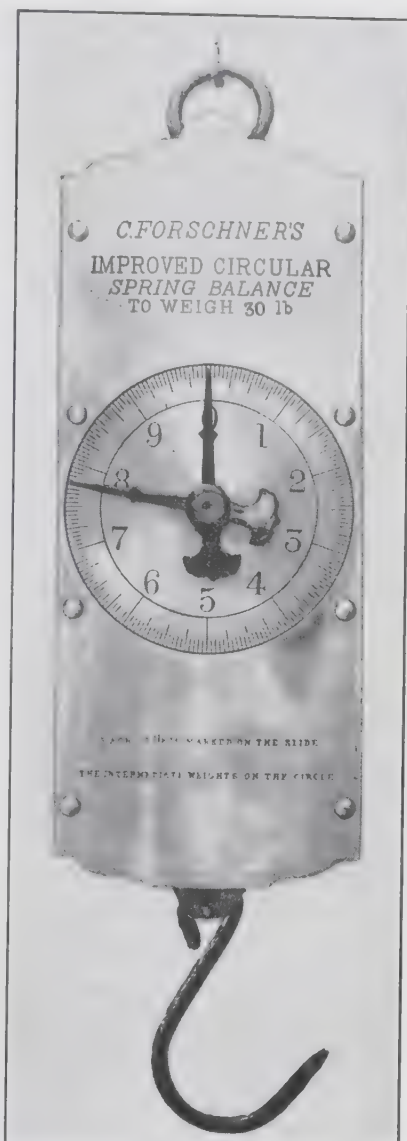


FIG. 34. SPRING BALANCE FOR WEIGHING MILK OR FEED

Two hands are provided, one of which may be set at zero to balance an empty weighing pail. The weight is then read directly from this hand.

ing of the milk helps to detect quickly any cases of illness, and also faulty milking, either by machine or by hand.

D. Compute milk production for month and year. Total the weights of the milk of each cow for all the milkings of the month and enter the total at the bottom of the milk sheet. Should the milk be weighed only a few days in the month, for example the first three days of the month, total the weights for the three days, divide the total by three, and multiply by the number of days in the month. Now compute the amount of butterfat by multiplying the weight of the milk for the month by the percentage of butterfat as shown by the test. For example, assume that a cow produced 64.5 pounds of milk during the first three days of the month, or an average amount of 21.5 pounds daily. $21.5 \times 30 = 645.0$, the total for the month. If any cow was dried off during the month, the average daily production as based on the first three days' weights will, of course, be multiplied by the number of days in which the cow was milked rather than by the number of days in the month. Combine the totals for all the months of the year during which the cow was milked to find the annual production.

2. SAMPLING MILK FOR BUTTERFAT TESTS

The test of the milk of each cow changes as lactation advances, and is also influenced temporarily by many factors, so that a single test is not a reliable index of the true fat yield. Make a test each month, if possible. Directions for conducting butterfat tests of milk are outlined in the sections that follow.

Procedure:

- A. Provide sampling equipment.
- B. Make a composite sample.

A. Provide sampling equipment. Provide a pint jar for each sample of milk to be tested. Fruit jars having glass covers

may be used. Fasten on each jar two gummed labels or tags on which the herd number or name of a cow is plainly written.

Obtain a small, long-handled dipper and also a supply of corrosive sublimate preservative tablets. The dipper should have not over one-tenth the capacity of the jar. Place one of the tablets in each sample jar. The tablets need not be used when the samples can be kept from souring without them.

B. Make a composite sample. Take a sample of milk from each of the milkings of each cow during the first three days of each month. In doing this, first stir the milk well with the dipper after the milk has been weighed and the amount recorded and while the pail still hangs on the balance. Then place a dipperful of the milk in a properly labeled jar. Place the cover on the jar, and stir the contents by gentle rotation. Repeat this procedure at each milking for three days. The final, or composite sample, consists of the individual samples taken at each milking.

So large a number of factors affects the percentage of fat in the milk of an individual cow from milking to milking, including the length of time between milkings, feed, sickness, etc., that the test of a single milking is not a reliable guide as to the average test of that cow's milk, nor to her yield of butterfat over a period of several days' duration. It is, therefore, necessary to take samples of several milkings in order that the test may serve as a reliable guide.

3. TESTING MILK FOR BUTTERFAT

It is important that the percentage of butterfat in the milk be accurately determined. This may be accomplished most readily by the method described below.

Procedure:

- A. Bring samples to correct temperature.
- B. Mix the sample thoroughly.
- C. Measure milk into test bottle.

- D. Add acid and mix with milk.
- E. Whirl the bottles in the tester.
- F. Read the test.
- G. Clean the bottles.

Equipment:

Milk pipette of 17.6 cc. capacity, milk-test bottles, acid measure of 17.5 cc. capacity, tester, hot water, commercial sulphuric acid (sp. gr. 1.84), dividers, thermometer, watch or clock, small pail or dish, bottle brush, dairy washing powder.

A. Bring samples to correct temperature. The milk to be tested must be at a temperature of 60° to 70° F. to give the best results. If it is not at this temperature, place the jars containing the composite samples either in warm water or in cold water as may be required, while the rest of the equipment is being made ready. Be careful not to use water over 105° F. for warming the samples on account of the butterfat becoming oily, or "oiling off."

B. Mix the sample thoroughly. When the samples have reached the right temperature, mix the first sample to be tested by pouring it several times back and forth from the sample jar into a clean jar or dish. Be sure that any lumps of cream or curd have been broken up. Make the last transfer into the original jar bearing the label.

C. Measure milk into test bottle. As quickly as possible after mixing the sample, place the mouth over the large end of the pipette and draw the milk up above the mark. Take the pipette from the mouth, at the same time quickly placing the dry forefinger over the end of the stem to hold the milk in the pipette. Permit the milk to run down to the mark, by lifting the finger slightly. Hold the test bottle at an angle, insert the pipette about an inch, and allow the milk to run slowly down the side of the bottle. Blow the last drop from the pipette. When using a pipette having a small stem, the stem is inserted full length into the bottle and the pipette allowed to drain. If any milk is spilled while transferring the milk

to the test bottle, measure the milk into the pipette again and place in a clean test bottle. Label the test bottle on the roughened area with the herd number of the cow or the number of the sample.

For accurate results, make tests in duplicate, and if the duplicates do not check closely, repeat the test. Save the

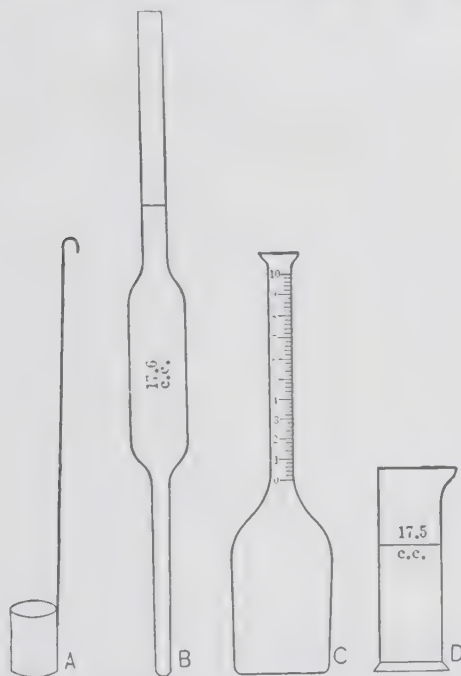


FIG. 35. EQUIPMENT USED IN TESTING MILK

(a) Small dipper for taking samples; (b) pipette for measuring milk; (c) milk-test bottle; (d) glass cylinder for measuring acid.

samples of milk being tested until the tests have been completed.

D. Add acid and mix with milk. Measure out 17.5 cc. of commercial sulphuric acid, which should be at about the same temperature as the milk (60° to 70° F.), by use of the glass acid measure or dipper, and pour it slowly and carefully down the side of the test bottle while holding the bottle at an angle. Rotate the bottle slowly, so that any milk in the neck of the

bottle will be washed down. When this has been correctly done, the acid should form a clear layer below the milk.

E. Whirl the bottles in the tester. When all the composite samples have been prepared in test bottles, as described, place the bottles in the tester, arranging them opposite each other

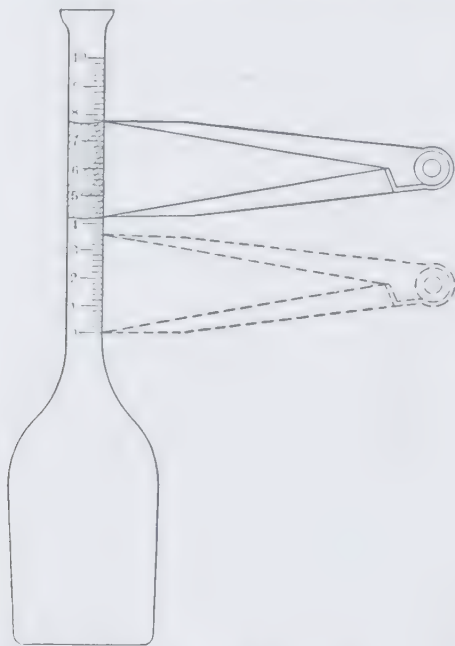


FIG. 36. METHOD OF USING DIVIDERS IN READING FAT COLUMN

The dividers are placed on the neck of the bottle so that the points are opposite the limits of the fat column. Without change in spread, they are moved on the scale so that the lower arm is at the zero mark. The upper arm then indicates the percentage of fat.

end of the graduated scale. Whirl the bottle again for one minute.

F. Read the test. Remove the bottles from the tester and place them in a small pail which contains hot water of sufficient depth to reach the tops of the fat columns in the test bottles. The water should have a temperature of 140° F

so that the weight in the tester is evenly distributed. Start the tester carefully and gradually increase the speed. Turn the crank, at the number of revolutions per minute indicated on the tester, for five minutes, and allow the machine to come to a stop gradually. Without removing the bottles from the machine, fill each of the bottles nearly to the neck with hot, soft water, or hot tap water to which a few drops of sulphuric acid have been added, using either the pipette or a specially designed cup for the purpose. Whirl the bottles again for two minutes. Again add hot water to each bottle until the liquid in the bottle comes within half an inch of the upper

Leave the bottles for at least five minutes, until their contents have attained the temperature of the water, when the test is ready to be read. Remove one bottle at a time from the water bath and read promptly.

Hold the bottle at about the level of the eye and in a strong light. Place dividers over the graduations covered by the fat column, one point being placed at the extreme upper end of the column, and the other at the extreme lower limit of the column. Both the upper and lower ends of the fat column are somewhat sunken in the center. A correct reading is made by reading to the extreme upper and lower limits of the column.

The fat column, at the time the test is completed, should be a clear yellow color and contain no charred flaky material. Fat columns containing dark lumps or flakes and lacking uniformity indicate that too much acid was used, that the acid was too strong, or that either the milk or the acid was too warm. In making further tests, reduce the amount of acid and have the milk and acid at a temperature of 60° to 70° F. Fat columns that are light green or grayish in color, or are cloudy, with particles of undissolved curd in them, are the result of using too little acid, acid that is too weak, or of having milk or acid too cold.

Bubbles occurring at the top of the fat column, making reading difficult, are usually the result of using hard water to fill the bottles. Soft water should be used, or hard water may be boiled or treated with a few drops of sulphuric acid to precipitate the minerals and thus prevent the trouble.

G. Clean the bottles. Clean the bottles soon after the test has been completed. Empty them by shaking vigorously up and down to remove the grayish deposit. Do not pour the liquid into sinks unless these are stone, or lead-lined, and equipped with lead waste pipes. Rinse the bottles with warm water, and then shake some dairy washing powder into each and brush out the necks by means of a bottle brush and hot water. If some sediment adheres to the bottle, dissolve with

a little acid, then rinse out. Rinse in clear water and invert to dry.

4. CALCULATING BUTTERFAT YIELDS

Compute the production of milk in the same manner as outlined in Section 1 above. Assume that the amount of milk produced by cow A for the month was 645 pounds and the test 4.5 per cent. Then $645 \times .045 = 29.025$, the number of pounds of butterfat produced during the month. Total the production for the different months to find the yield for the year.

5. DETERMINING MILK AND BUTTERFAT YIELDS THROUGH THE AGENCY OF A DAIRY-HERD IMPROVEMENT ASSOCIATION

Cooperative agencies termed dairy-herd improvement associations are in operation in most states. About 1300 such associations were active in the United States in 1940.

Usually about twenty-six dairy farmers located in a county or community form a cooperative organization which hires a qualified tester. The tester spends one day a month at each farm. He records the amount and value of the feed each cow receives, and weighs and tests her milk. He calculates not only the production of milk and butterfat for each cow for each month and the year, but also the profit or loss from each cow. He may also offer suggestions regarding the feeding and management of the herd.

Dairy-herd improvement associations have been an important factor in eliminating the lowest-producing cows in the herds tested, thus raising the standard of production and greatly increasing profits. By comparison of the production records of daughters with those of their dams, many sires have been "proved." In most states these associations are under the supervision of the college of agriculture of the state university. Aid in forming such associations may be obtained by writing to that agency.

6. MAKING ADVANCED REGISTRY RECORDS

The colleges of agriculture or agricultural experiment stations of state universities supervise for the breed associations the making of Advanced Registry records within their respective states. The method of determining the milk and butterfat yields of each cow is similar to that of the dairy-herd improvement association except that the supervision is stricter. The herd-improvement registry test requires that production records be reported for all registered cows in a herd and thus differs from the Advanced Registry test which permits the owner to test only a few of his best cows.

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COMMUNITY STUDIES

Obtain from a county farm bureau agent, local cream station, condensery, milk shipping station, or some similar agency, the names of a number of dairy farmers in your community who are selling relatively large amounts of dairy products. Visit as many of these farms as possible and obtain answers to the following questions:

1. Are milk records of each cow being kept?
2. Are these records kept by the farm operator and his help or by some other agency?

3. Are advanced registry tests made?
4. What proportion of the cows from the herd have been sold because record keeping has shown them to be unprofitable?
5. Have better prices been received for cows or their calves because records had been kept?
6. Does the owner consider record keeping profitable?
7. If possible, obtain the production records of a number of herds over a period of years. Tabulate these in terms of average butterfat per cow each year for successive years. Has record keeping had a definite influence in improving the productive level of each of these herds?
8. Has record keeping on the farms visited been a means of identifying valuable sires?

CHAPTER VI

STUDYING THE PRINCIPLES OF HEREDITY

About the middle of the last century an Augustinian monk working in the garden of a monastery at Brunn, Austria, made an important discovery. It cannot be said that this discovery took the world by storm nor was it, at the time, accepted as being of any particular significance. In fact, the world either did not know (the experiment was published in an obscure publication) or knowing did not understand, because Gregor Mendel's discoveries were forgotten for almost half a century. In fact, he died without knowing their real significance.

Had it not been for the investigations of three scientists working simultaneously, but independently, the world, even now, would probably be without any knowledge of Mendel's discoveries. The investigators referred to were Correns, a German; Tschermak, an Austrian; and De Vries of Holland. These men, since none of them were, at the time, familiar with Mendel's work, actually rediscovered the same laws that Mendel had demonstrated almost fifty years before.

It would hardly be within the range of truth to say that had it not been for Mendel's discoveries we would be lacking our present understanding of Mendelism, since the findings of Correns, Tschermak, and De Vries would have started the investigations that for the most part have established our knowledge of heredity. By the same reasoning the loss to the world of Mendel's discoveries should in no way detract from the fact that it was, after all, Mendel who was the first to understand certain of the laws of heredity.

It is not particularly important to us in our studies now, to review the experiments of Mendel. Even though Mendel made basic and lasting contributions to our understanding of breed-

ing, he did so without knowing very much about the mechanism of heredity. In short, in light of our present knowledge, you can have a more complete and well-rounded knowledge of heredity than was available to Mendel.

Operations:

1. Observe some facts about living matter.
2. Study the mechanics of heredity.
3. Become familiar with basic laws of heredity.
4. Apply Mendelian principles to simple inheritance.

1. OBSERVE SOME FACTS ABOUT LIVING MATTER

It was not until the discovery of the microscope by Schwann that it became known that the body was made up of small and somewhat independent units known as cells. Further studies demonstrated that these cells differed in form and function. Even before the identity of the cell was established, it was known that different parts and organs of the body performed different functions, but their structure and functions could not be clearly established without the aid of the microscope and other tools of science.

Procedure:

- A. Observe the structure and function of a cell.
- B. Note the nature and function of reproductive cells.
- C. Differentiate between sperm and ova.

A. Observe the structure and function of a cell. So far as heredity is concerned, the cell is an important structure. Basically it is made up of a substance known as protoplasm. This protoplasm may be further differentiated into cytoplasm and nucleoplasm. The cytoplasm constitutes the major portion of the cell and is important in growth and as a vehicle to carry the nucleus. The nucleus is a small, differentiated bit of protoplasm and contains the chromatin material vital to reproduction and growth.

A large number of differentiated cells are grouped together to form the reproductive system of the animal. Such cells and groups of cells appear to be beyond the influence of external factors and therefore immune to environmental effects. In short, the germ plasm or hereditary characteristics of an animal are not changed by any external influences to which the animal itself may be subjected. This point is important in heredity.

B. Note the nature and function of reproductive cells. Early in the life of the embryo of any individual, certain cells are set aside that are destined to perpetuate the race. Although such cells may have secondary functions, such as secreting hormones, or substances that influence the development of the individual, secondary sexual characters, etc., their primary function is that of reproduction. Such cells are independent, from an hereditary standpoint, of the body cells and are not influenced in their transmission of hereditary characters by conditions which might, and often do, have a lasting effect on the body cells of the animal. This very fact is highly important in preserving the identity and specific nature of the characteristics of an individual.

C. Differentiate between sperm and ova. In most animals reproduction requires a contribution from both sexes. In the female the ovary contributes at regular intervals (in the cow it is approximately 21 days) a single cell known as the ovum. In this cell there is present all the characteristics which the mother can and does transmit to her offspring. This cell, however, would never function in the creation of a new individual unless the reproductive cell of the opposite sex, known as the sperm or spermatozoa, unites and fuses with it. Together, by this union, the contribution of the male, the sperm, and that of the female, the ovum, form a single cell that, under proper conditions, becomes a new individual. This single cell (known as the zygote) possesses all the hereditary characteristics that will develop in the new individual and many of those possessed by the race from which it comes.

This, you will observe, is a very significant stage or point to a breeder in shaping a herd or breed because it definitely shows that the only control, within the power of the breeder, over the hereditary characters of an animal lies in the selection of parents that possess the characters that he seeks to perpetuate.

2. OBSERVE THE MECHANICS OF HEREDITY

It is so much easier to understand heredity if in your early studies you become familiar with the physical basis of heredity. It is just as essential to have a vehicle to carry hereditary characters from one generation to the next as it is to have a conveyance to take you from one country to another.

In a relay race there are several runners (usually four). Each runs a portion of the distance to be covered. When the first runner takes his marks, he usually carries in his hand a baton. This baton is expected to be handed to the second runner, who in turn passes it to a third and he to a fourth. By the interchange of the baton, it is evident that a contact has been made between each man in the race. This baton is real, it is physical, and it is the only thing that began the race and finished the race. There is a parallel to be drawn between the relay race and the passage of characters from generation to generation. The ovum and the sperm are the physical vehicles that convey all of the characters possessed by the individual to the next generation. Insofar as they are physical and are passed on to another individual, they may be compared to the baton. An individual lives, reproduces, and dies, but his or her characteristics live on in succeeding generations.

Procedure:

- A. Study the gene.
- B. Learn the function of the chromosome.
- C. Become acquainted with growth and differentiation.

A. Study the gene. The gene is so minute in size that it is doubtful if anyone has ever seen one even with the most powerful microscope. Just recently Bridges¹ reports that he has observed one in specially prepared tissues. Yet, minute as the gene is, it possesses the ability to transmit a character from one generation to the next. It is, therefore, extremely important to know how genes behave in this whole process of heredity. The gene being so small might be lost or destroyed except that nature has provided a sort of chain to which they are attached or fastened, very much as links are on chains we are accustomed to see and use. These chains or rods of genes are known as chromosomes.

B. Learn the function of the chromosome. The chromosome is the unit of transmission of genetic characters from animal to animal. There is a definite number of chromosomes for a given species. This number, except in unusual cases, remains the same. Furthermore, these chromosomes occur in pairs, one member of a pair being from the mother received through the ovum and the other from the father carried in the sperm. Thus you can see that the ovum and the sperm each carry one-half the hereditary characters of the individual. In the formation of the ovum and the sperm, nature has provided a method for splitting the chromosomes so that only one-half the total number is present. If this were not true, the number of chromosomes would double in each new generation and would interfere with the mechanism of the physical basis of heredity.

C. Become acquainted with growth and differentiation. Growth is really cell multiplication. One cell divides into two, two into four, and finally by this method literally millions of cells are formed, but, growth involves more than merely a multiplication of cells. There is a plan or pattern that directs growth just as there is a plan by which a house or a large building is constructed. This plan or pattern of growth is

¹ C. B. Bridges, Professor of Biology, Carnegie Institution, Pittsburgh, Pa.

regulated by the determiners for the different characters. If we could, for instance, hold the environment under which two animals develop exactly the same, then such differences as do exist would be due solely to the influence of genes or determiners. The difference between a good and a poor cow would then be accounted for by the genes which it had inherited from its parents, a very important point for the dairyman.

3. LEARN THE BASIC LAWS OF INHERITANCE

The genes are the bearers of hereditary determiners and are fastened together into a rod-like form known as a chromosome. Therefore, if we know how the chromosome is carried or transmitted from generation to generation, we can then predict what will happen to the characters for which the genes on that chromosome are responsible. In general, the laws which regulate the behavior of genes and chromosomes in such cases are relatively simple.

Procedure:

- A. Note that chromosomes and genes are independent units.
- B. Observe the effect of recombination of genes.
- C. Study the significance of linkage.
- D. Learn how sex is determined.

A. Note that chromosomes and genes are independent units.

If you were to put several chemicals together, they would mix or mingle and no one of them could be recovered in its original form from the mixture. On the other hand, if you were to put marbles into a box, their identity would be retained and you could remove any individual marble from the box without affecting the other marbles except perhaps to change their position slightly. Genes and chromosomes are, therefore, much like marbles. They have an identity which they retain and the presence of other genes and chromosomes, except in rare cases, does not affect their function or form.

When the normal number of chromosomes for a species is reduced to one-half, as it is in the formation of the sperm and ovum, the particular chromosome of a pair that is included is determined by chance. A good example of chance is the tossing or matching of pennies. When a penny is tossed into the air, there are two alternatives as to how it will land. It can come down heads or tails. If you toss the penny enough times, there should be as many heads as tails. Something similar happens when only one of a pair of chromosomes



FIG. 37. CROSSBRED COWS, A PORTION OF THE FIRST-GENERATION CROSS BETWEEN THE GUERNSEY AND HOLSTEIN BREEDS

These cows were very satisfactory producers, had a conformation about midway between the parental breeds, and on the whole were satisfactory dairy animals.

can be included in an ovum or sperm. The chances are equal that the chromosome from the mother will be included in a particular ovum or sperm or that the one from the father will be present. Therefore, there is an equal chance that the individual may receive a given character from his mother or from his father.

B. Observe the effect of recombination of genes. We have learned that chromosomes and for the most part (exceptions will be mentioned later) genes exist as independent units. This being true, there are many opportunities for different

combinations to be found in each sperm and each ovum. When these in turn unite with mates to form a new individual, still further combinations exist. These combinations, however, occur in definite ratios and obey general laws, and by understanding these we acquire a knowledge of heredity.

C. Study the significance of linkage. All the genes that are located on a particular chromosome are fastened more or less definitely together (exception referred to in Section B). This condition is known as linkage. Consequently, wherever the chromosome goes, all the genes linked to that chromosome go with it, and all the characters determined by those genes are present in the animal.¹

D. Learn how sex is determined. Genetically the difference between a male and a female is the absence or presence of a chromosome. This particular chromosome is known as the sex chromosome. All the chromosomes except this one occur in pairs in animals of both sexes. This one, however, has a mate in the female of the higher forms of mammals but none, or in some forms a rudimentary one, in males.

The presence or absence of this extra chromosome is explained as follows: Every ovum produced has a sex chromosome included with the regular chromosomes, but sperm are always of two types and these types occur in essentially equal numbers. These types are alike in all respects except that one possesses a sex chromosome and the other does not. When the one with the sex chromosome unites with and fertilizes an ovum, a female is produced, but when the type without the sex chromosome fertilizes the ovum, a male is produced. Therefore, we would expect essentially the same number of males born as females and this is observed to be so.

¹ Cases involving crossovers do occur, but an explanation of the phenomenon of crossing over is considered too technical for this text.

4. APPLY MENDELIAN PRINCIPLES TO SIMPLE INHERITANCE

We now have a working knowledge of the physical basis of heredity. This understanding convinces us that heredity is, after all, a natural process, controlled by delicate mechanisms that obey certain laws. Let us now apply these laws to the inheritance of certain characters in cattle.

Procedure:

- A. Study the nature of a unit character.
- B. Distinguish between a dominant and a recessive.
- C. Notice how a unit character is transmitted from generation to generation.
- D. Learn the unit characters in cattle.

A. Study the nature of a unit character. A single gene is usually responsible for a given unit character. Let us take, for instance, the horned condition in cattle. Here we usually consider that there are two alternatives. An animal is polled, as we observe for instance in the Angus breed, or it is horned as we find in the Holsteins or Jerseys. Another and distinctly different set of genes is responsible for solid or self-color and for the alternative condition of spotting. Thus, we might have a number of individual characters in cattle controlled by distinct and separate genes.

B. Distinguish between a dominant and a recessive. In each of the cases mentioned above (Section A) there were alternative conditions. An animal could be polled or it could be horned. It could not, however, be both. There is a genetic difference between these two alternatives. The polled condition we say is *dominant* to horns. In other words, when the polled condition is received from one parent only, it dominates over or overshadows the horned condition received from the other parent, thus preventing horns from developing. The horned condition can, therefore appear only when it is inherited from both the father and the mother; it is, then, pure

and horns develop. Such a condition is known as *recessive*. Similarly, solid color is dominant to spotting. Most unit characters possess a dominant and a recessive condition and the recessive can appear only when it is received in that form from both parents.

C. Notice how unit characters are transmitted from generation to generation. In Holstein cattle there is a unit character that prevents the registration of an animal in the herd books of the association. It is a character known as red and white. This condition or character is recessive. Let us now assume that we have two black and white parents that have a red



FIG. 38. EXCELLENT LIFETIME PRODUCERS

Every cow in this group has produced over 100,000 pounds of milk in her lifetime. Several of them have produced 150,000 pounds, and one, the first animal on the right, has been credited with 180,000 pounds of milk.

and white calf. Obviously, each of the parents has inherited black and white from one of their parents and red and white from the other. The male will produce sperm that are of two types. One type will have the ability to produce red and white, the other type black and white. The same is true of the female. In her case, the ovum, like the sperm, can carry the gene that produces red and white or the one that produces black and white and the chances are even with respect to which condition it will be. This condition is indicated with symbols in Table XVII.

Of these progeny, all that carry *B* are black and white in color, although from a transmitting standpoint they are of two

types. Three-fourths of the individuals born to parents of the above type are black and white, and therefore appear to be like their parents. Actually only two-thirds of these black

TABLE XVII

EXPLANATION OF OCCURRENCE OF RED AND WHITE PROGENY
FROM BLACK AND WHITE PARENTS

B = Gene carrying black and white

b = Gene carrying red and white

Item	Bull		Cow
Color of parents	Black and white		Black and white
Kind of sex cells possessed by parents	Sperm <i>Bb</i>		Ovum <i>Bb</i>
Kind of genes produced by parents	Sperm <i>B</i> and <i>b</i>		Ovum <i>B</i> and <i>b</i>
Ratio of genes produced by parents	1-1		1-1
Kind of offspring expected of these parents	<i>BB</i>	<i>Bb</i>	<i>bb</i>
Ratio of offspring expected of these parents	1	2	1
Color of offspring	<i>BB</i> Black and white	<i>2Bb</i> Black and white	<i>bb</i> Red and white
Ratio of black and white to red and white	3 Black and white		1 Red and white

and white animals are, from a hereditary standpoint, like their parents. The other individuals, representing the remaining one-third, are different and can produce only genes that carry the ability to produce black and white.

The single individual of the four offspring is red and white. It is the one that we have identified as *bb*. This animal is pure for red and white and can transmit nothing but red and white to its offspring. It is only when mated with an animal carrying *B* that black and white can be introduced into the progeny of a red animal.

D. Learn the unit characters in cattle. Genetic studies are constantly demonstrating the type of inheritance of certain characters. The following list shows the dominant and recessive condition of most of the unit characters so far demonstrated in cattle.

UNIT CHARACTERS IN CATTLE—INHERITANCE KNOWN

DOMINANT CONDITION	RECESSIVE CONDITION
White	Colored
Black color	Brindle, yellow or red
Color-sided	Uniformly colored
Dexter (short leg)	Leg, normal
Ear, notched	Ear, normal
Eye, normal	Congenital cataract
Hernia, umbilical, sex-limited	Normal
Head, normal	Bulldog head
Muscle, normal	Muscle, contracture
Polled	Horned
Polydactylism (extra toes)	Normal hoof
Switch, black	Other color
Tongue, pigmented	Tongue, clear
Udder, 2 quarters on a side	Udder, 1 quarter on a side

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CHAPTER VII

APPLYING THE PRINCIPLES OF HEREDITY TO DAIRY CATTLE BREEDING

For the past quarter of a century or more, industry has set its goal toward greater efficiency. More and better machines, capable of producing more units and at lower unit cost, has been a major objective. If lathes and motors and dies are the machines of industry, then cows may be considered the machines of dairy production. Dairy men everywhere are beginning to appreciate the necessity of having better and more efficient animal machines.

The average annual production of dairy cows in the United States is low. It has been demonstrated that in the United States cows kept mainly for milk production yield on the average less than 4500 pounds of milk annually. United States Department of Agriculture estimates for certain years and certain states are frequently lower than this figure. No matter what the source of information, average yields approximating those given are too low for the establishment of a profitable dairy industry. Such yields under most conditions barely meet the feed cost of milk production.

The yield of a cow for any given period, whether expressed in terms of pounds of milk or pounds of butterfat, is determined by the interaction of two major factors, heredity and environment. Environment, a general term including all the conditions under which an animal is forced to live, is alone responsible for all the increases or decreases in production that may be effected in animals of similar heredity. It should be clearly set forth here, also, that such environmental factors as feed (both qualitatively and quantitatively calculated) climatic conditions, seasonal influences, management,

health of animal, etc. are all significantly important in establishing the yield or level of production of animals with different hereditary capacities. The best hereditary talents for production cannot, therefore, find expression without favorable environmental opportunity.

One of the authors is familiar with a herd of pure bred Holstein cattle that had an average production per cow in dairy-herd improvement testing, for four consecutive years, of 9178 pounds of milk, 305.3 pounds of fat; 9858 pounds of milk, 326.1 pounds of fat; 9096 pounds of milk, 296.2 pounds of fat; and 8083 pounds of milk, and 276.7 pounds of fat, respectively. The management was then changed and the same animals, with the exception of the addition of two or three first-calf heifers produced on the farm and the elimination of two cows, averaged 15,647 pounds of milk, 540.3 pounds of fat; 15,221 pounds of milk, and 563.6 pounds of fat per cow, respectively, for each of the next two years. This increase in fat yield was due to an improved environment and better opportunity, since the hereditary capacity was the same or essentially the same for the six-year period.

The herd to which reference has just been made was of excellent breeding or possessed of superior germ plasm, otherwise the increase noted could not have been obtained.

Heredity is, therefore, the second of the two major factors to be considered in determining the level of production of our dairy herds. In general, the average dairy farmer is better informed in matters of feeding, care, and management than he is in his knowledge of the laws of heredity that apply to dairy cattle. This need not be so since much new information on this point has been developed and utilized by some farmers within the past twenty years.

Operations:

1. Learn how the quantitative characters in cattle are inherited.
2. Determine how selection helps the breeder.
3. Become familiar with the genetic tools of the dairyman.

4. Study the sire problem.
5. Plan your breeding program.
6. Familiarize yourself with the trends in breeding cattle.

1. LEARN HOW THE QUANTITATIVE CHARACTERS IN CATTLE ARE INHERITED

We have, in the preceding chapter, discussed at some length the inheritance of unit characters—their appearance and function determined by a single gene. Many characters are not so simply or regularly transmitted from one generation to the next. This more complex heredity includes many characters of economic value, and an understanding of the genetic behavior of such characters is very important and should be added to the knowledge of a well-informed breeder of dairy cattle.

Procedure:

- A. Observe the type of character involved.
- B. Determine the mechanism for this type of inheritance.
- C. Become familiar with the behavior of such inheritance.

A. Observe the type of character involved. Many years ago James Wilson in his book, "Principles of Cattle Breeding," undertook to explain the inheritance of milk-yield ability by assuming that one or at most two factors were responsible for the transmission of the character. Other investigators could not agree with his observations. A few years later Castle, working with rabbits, showed that size of head was determined by not one but several genetic factors. As investigators have studied other characters of this type, it has gradually become apparent that a considerable group of characters is of essentially the same general nature and inherited in much the same way. Such characters in dairy cattle are: size of animal, milk yield, per cent fat content of milk, form or conformation of animal, etc. Characters of this type are complex and often closely related to or correlated

to each other. They are, for the most part, of important economic significance.

B. Determine the mechanism for this type of inheritance.

If you have been a boy scout and observed or participated in a tug of war, you know that it takes the combined effort of some ten different individuals all pulling on the same rope at the same time to make a favorable impression or to constitute a good team. In this game, each boy exerts a certain pull or adds his increment of power or draw to the rope. Boys of different sizes and strengths exert a different amount of pull, but the sum of the pulls of each individual boy, no matter what



FIG. 39. SIX REPRESENTATIVES OF THE ILLINI NELLIE FAMILY

This family, produced from one cow and by intensive inbreeding, is being studied by a number of interested breeders from many different parts of the country. The development of families is something for breeders to consider more seriously.

it may be, determines the total pull. Similarly, by analogy, several independent factors or genes all contributing, perhaps in different amounts to the same character (let us, for example, assume milk yield), determine the capacity of the cow to produce milk. We should also remember that the hereditary capacity of the cow and the actual yield of milk may not be the same because the environment or opportunity is likewise very important in determining the actual yield. It is just as important, in fact, as the footing or training of a team in determining the amount of their combined pull in a tug of war. This type of inheritance is usually spoken of as "blended" inheritance, meaning that the resulting offspring in such instances possess hereditary ability midway between their

parents. An offspring, therefore, represents a sort of "blend" between its parents.

C. Become familiar with the behavior of such inheritance. The University of Illinois in 1919, purchased all the animals then living that had been produced in the "Bowlker" breeding experiment first begun in 1911, by the late T. J. Bowlker of Framingham, Massachusetts. These animals were moved to the University of Illinois and continued in a long-time breeding experiment. Many points regarding the inheritance of such characters as milk and fat yields and percentage of fat content, then unknown, have been clarified by this and other experiments.

TABLE XVIII

INHERITANCE OF CERTAIN CONSTITUENTS OF MILK—
BOWLKER HYBRID HERD

Breed Identification	Constituent of Milk—Expressed in Per Cent			
	Fat	Protein	Lactose	Ash
Guernsey Parent.....	5.033	3.920	5.100	.7540
Holstein Parent.....	3.413	3.101	4.918	.6836
F_1 Generation.....	4.352	3.429	5.007	.7314
F_2 Generation.....	4.247	3.511	4.989	.7189
EXPECTED—Based on Theory of Inheritance.....	4.223	3.510	5.009	.7188
Deviation from Expectation in F_1 Generation.....	+.129	-.081	-.002	+.126
Deviation from Expectation in F_2 Generation.....	+.024	+.001	-.020	+.001

It was found, for instance, that when cows of the Holstein breed were crossed with bulls of the Guernsey breed, the resulting offspring produced a yield of milk approximately half-

way between that of their Holstein and Guernsey parents. The results were the same in reciprocal crosses, or when Guernsey cows were mated to Holstein bulls. In this particular experiment, the Holstein cows at 2.8 years of age produced, on the average, on two-times-per-day milking 7673 pounds of milk. The average, on the same basis, of the Guernsey cows from which the bulls were selected was 4617 pounds of milk. The offspring produced 6412 pounds of milk. The mid-value between the two yields was 6145 pounds of milk, or the value expected from the assumption above. Table XVIII shows the results of this experiment for percentage of fat content as well as the other constituents of milk.

Let us, therefore, summarize the inheritance of this type of character by saying that in general the offspring have a value or a transmitting ability essentially midway between that found for their parents. This point is especially important in breeding dairy cattle.

2. DETERMINE HOW SELECTION HELPS THE BREEDER

The word "selection" presupposes that there are alternatives between which one has an opportunity to choose. In other words, there is variation among individuals. The good breeder of dairy cattle is constantly striving to get rid of genetic variation or differences, but the tools that he uses to introduce improvement work most rapidly when variation does exist.

To get an idea of the extent of variation in dairy cattle consult Table XIX.

This table groups, on the basis of butterfat yield, all the dairy cows in the state of Illinois tested during the year 1939, in dairy-herd improvement associations.² This group of 20,015 cows, located in all parts of the state and representing all breeds, gives perhaps one of the best estimates of production available for better dairy cows. This group is also fairly

² Dairy-herd Improvement Associations are organizations of farmers cooperatively testing their herds for butterfat production.

typical of the variation found generally over the country for cows of this level of production. Since this table also shows feed cost of production, it is easy to observe the relation of cost to yield.

TABLE XIX

VARIATION IN PRODUCTION OF COWS IN DAIRY-HERD IMPROVEMENT TESTING FOR YEAR 1939

Group	Number of Cows	Pounds of Milk	Pounds of Fat	Value of Product	Returns above Feed Cost
Under 150 lb.	248	3,116	124.6	\$ 50.01	\$ 5.06
150-200 lb.	854	4,826	179.7	74.80	28.78
200-250 lb.	2473	6,111	228.1	95.02	45.59
250-300 lb.	4268	7,397	278.9	115.62	62.80
300-350 lb.	4787	8,404	323.4	133.42	78.41
350-400 lb.	3670	9,483	372.9	152.68	94.66
400-450 lb.	2081	10,510	423.4	171.89	110.37
450-500 lb.	968	11,469	470.6	193.58	129.24
Over 500 lb.	666	12,990	541.7	231.74	159.77

Even in a population of cows, such as those indicated in the above table, it is easy to observe that there are wide differences between the best and the poorest. Let us then proceed to analyze this problem of selection.

Procedure:

- A. Select to eliminate undesirable characters.
- B. Select to improve or intensify desirable characters.
- C. Select to add new and better germ plasm.

A. Select to eliminate undesirable characters. In Chapter VI it was pointed out that there is a physical basis of heredity and that the gene is the small particle of protoplasm responsible for the transmission of a unit character from one generation to the next. The gene is relatively permanent and

always exerts the same influence. Therefore, if the gene is responsible for the production of a bad character, it continues to transmit that badness. If it perpetuates a good one, it will always transmit that quality.

Some years ago one of the authors stood before a very old shrine in an ancient cathedral. On a hand-wrought candelabrum he observed some very large candles burning. Under each candle was a cone-shaped pile of tallow three or four



FIG. 40. SIRE AND EIGHT OF HIS EXCELLENT DAUGHTERS

This bull, an excellent individual himself, is shown with eight outstanding daughters. Note the uniformity, excellent conformation, and splendid udders on every cow of the group.

inches high, indicating that the candles had been burning for a long time.

Asking a caretaker standing by how long these candles had been burning, he was surprised to find the caretaker did not know.

Then the old caretaker recounted this story.

"Each time as a candle burns low," he said, "we light a new one with the flame of the old, and so the same flame burns on. To my knowledge this has been done for twenty-one years,

and I am told, and I believe it is true, that the same flame is burning now that was burning more than fifty years ago."

If we liken the flame to a gene and compare each candle to a generation, we have a striking parallel to life. The sperm and ovum unite and a new individual is created. The gene fulfills its mission of establishing the character for which it is responsible and is then passed on to another generation where it does the same thing. Individuals, like candles, are destroyed or die; but the gene, like the flame, lives on. This

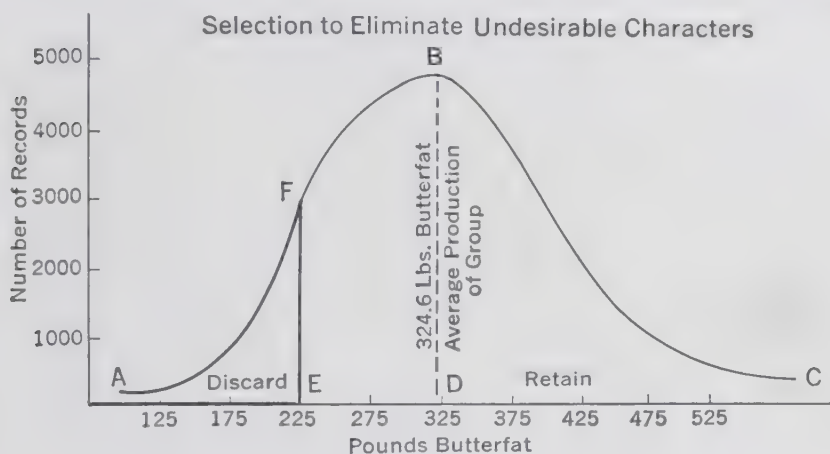


PLATE 4.

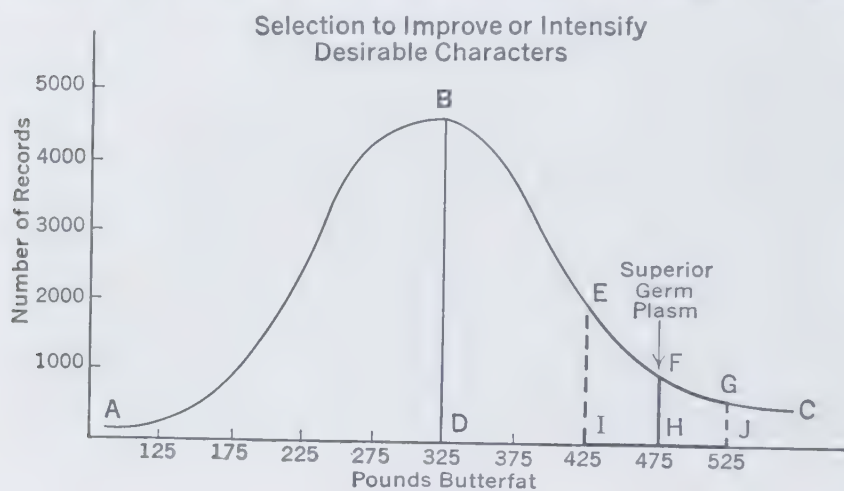
gives us a most important principle or fact to observe in selection.

Good genes stay good, bad genes stay bad; and the only way to eliminate a gene, good or bad, is to prevent its reproduction. Our first job in selection, then, is to discover the bad genes to prevent their perpetuation.

The curve in Plate 4 is based on Table XIX and graphically illustrates the range in production of cows tested in dairy-herd improvement associations.

Let us assume that we do not care to retain, for breeding purposes, cows that produced less than 250 pounds of fat. We, therefore, erect a perpendicular at *E* which bisects the

curve at *F*. All the animals whose production places them in the area *AEF* are discarded. It is assumed, and on the average it is true, that such animals possess inferior germ plasm and it is not desirable to retain progeny from them. Since their production is usually uneconomical, it is also unwise to retain them for production purposes. When this group of animals is removed or eliminated, the average of the remaining animals is higher, and the genetic quality (germ plasm) remaining for the group as a whole has been improved. In other words, fewer bad genes remain. It is in



this manner that we explain the effect of selection to eliminate undesirable characters.

B. Select to improve or intensify desirable characters. Let us refer again to the preceding curve.

In Plate 5 we select a small group from among the better animals. The average production of this group is expressed by the line *HF*. No animal in this selected group yields less than *EI* or more than *JG*. If such animals are mated to others of equal ability, their progeny will be considerably above the average of the group represented by line *DB*, but will not be quite so high as the average for the selected group represented

by line *FH*. This fact is explained as regression. Regression is sometimes spoken of as the "pull of the average." The average here being represented by the line *DB*. The success with which one is able to select from this small superior group will depend upon the purity of the hereditary qualities of the animals. If they have been bred for a long time with very little variation among themselves, they may be expected to breed relatively true.

This fact is well illustrated in Fig. 41 which shows six daughters, all milking, of the Jersey cow, LaFosse Golden Beauty, 772539. These daughters are by three different sires and all are outstanding. Evidently this cow possesses a germ plasm that is relatively pure for the desirable qualities sought in this breed, and can transmit nothing but desirable qualities. Such purity of germ plasm, especially in sires, is highly prized by dairy cattle breeders.

C. Select to add new and better germ plasm. By following the procedure or methods of selection explained in Sections A and B above, that is, eliminating undesirable characteristics possessed by the lower-producing or less desirable animals; and then selecting for greater opportunity of those better than the average, the mean production and genetic quality of the herd or group should be raised and the amount of variability reduced. These two procedures will carry a herd to a certain point after which it will remain relatively constant.

To make progress from this point, it is necessary to add a new type of selection. This type requires the selection of qualities from new and outside sources, better than those already possessed in the herd or group. This constitutes a somewhat difficult problem and more study is required to be successful in this than in either of the other types of selection. Suppose, for instance, that a Holstein breeder has a herd on which he has practiced selection of the first two types. His herd tests, on the average, 3.2 per cent butterfat. He wishes to raise this test to 3.7 per cent butterfat. He must go into some other herd and select a bull or perhaps also some cows



FIG. 41. SIX DAUGHTERS, THE PRODUCE OF ONE COW

These six daughters by three different sires serve as an outstanding record of the splendid genetic qualities possessed by the cow, La Fosse's Golden Beauty.



FIG. 42. HOLSTEIN COW, DAM OF BULL IN PEDIGREE

This cow is an excellent individual and has six full sisters, all splendid animals. She is the right kind of cow to be the dam of a herd sire.

that possess high fat test. No amount of further selection in his own herd, if none of his cows test so much as 3.7 per cent fat, will make it possible for him to reach his objective. If he is able to secure a bull whose average transmitting ability is 4.0 per cent butterfat, the breeder is then able to introduce the quality sought and then by further application of Procedures A and B should improve the average percentage fat test of his herd. Other qualities sought but not existing in the herd must be secured by this same method of selection.

3. BECOME FAMILIAR WITH THE GENETIC TOOLS OF THE DAIRYMAN

The better breeders of dairy cattle are constantly striving to improve the genetic qualities (germ plasm) of their cattle. To do this effectively, certain systems of mating are practiced that when understood and applied properly will shorten the time required to effect the improvement, make the improvement more certain, or insure greater total improvement. In any event, such methods may be classed as tools, not new tools perhaps but more highly appreciated and more intelligently applied when their function is understood.

Procedure:

- A. Observe the effects of outbreeding.
- B. Study line breeding.
- C. Learn the principle of inbreeding.
- D. Examine the results of crossbreeding.

A. Observe the effects of outbreeding. The average dairyman practices the policy of selecting each sire from unrelated stock, that is, unrelated to his herd or to the animals with which the bull is to be mated. Such a system is called "outbreeding" and is considered to be a safe method to pursue. In this method, sires that have good prospects of transmitting the characteristics desired are selected from lines of breeding

not related or distantly related to the herd in which the sire is to be used. The subsequent sires are selected in the same way from still other strains or lines of breeding.

This system has one or possibly two advantages. In the first place, it prevents characters from becoming pure, that is, inherited from both parents; and therefore objectionable recessive characters, such as blindness and udder defects listed



FIG. 43. HOLSTEIN COW, DAUGHTER OF ANIMAL IN FIG. 42

This heifer, shown as a two-year-old with her first calf, is an excellent individual and the full sister to the bull in Pedigree No. 1.

on page 108, are less likely to show up. It is presumed also that this system makes for more vigorous progeny.

The main difficulty encountered in this method of breeding is that it introduces variability and makes it extremely difficult to have a herd that is really uniform in many of its characters. Such a system also makes it difficult for a breeder to produce his own sires. In purebred cattle it makes it almost

impossible for the breeder to sell bulls to other breeders who are following definite families or strains in their breeding programs.

B. Study line breeding. In point of principle, line breeding and inbreeding are very similar. The difference between them is the degree of relationship involved and not the genetic principles employed. Both line breeding and inbreeding purify genetic characters, but inbreeding is the more intensive of the two systems.

Line breeding consists in mating distantly related animals. The degree of relationship employed corresponds to that of cousins or second cousins in human relationships. Such a system develops uniformity and purity of germ plasm. It is, like outbreeding, relatively safe in its application and is looked upon favorably by most of the better breeders of dairy cattle. It is employed extensively by breeders of purebred cattle.

C. Learn the principles of inbreeding. Inbreeding is the mating of closely related individuals such as parent and offspring, brother and sister, etc. Most of the early experiments in inbreeding produced unfavorable results. Crampe, Ritzema-Bos, and others all reported that their work with rats demonstrated inbreeding to be responsible for reduced fertility, lack of vigor, sterility, and occasionally monstrosities. As a result of these and other experiments, as well as common observation and experience, inbreeding fell into disfavor and breeders everywhere avoided its use.

A better understanding of the principles of heredity and subsequent experimental evidence makes it possible to explain the unfavorable results of early investigators and account for the success of present-day experiments and practices.

In the first place, the laws regulating the transmission of a character from one generation to the next are the same in inbreeding as they are in outbreeding or other forms of mating. The favorable or unfavorable effects of inbreeding are not, therefore, inherent in the method of mating but occur as the effects or results of such matings.

Most objectionable characters are recessive; that is, to appear at all they must be inherited from both parents. Such characters when they do appear are pure and breed true. Since closely related animals possess similar germ plasma, the probabilities are that they will likewise possess many of the same genes. It is then to be expected that these like genes meeting each other must result in the same character's being



FIG. 44. A SECOND-GENERATION COW FROM CROSSBRED PARENTS

This cow possesses some of the characteristics of the Guernsey and the color of the Guernsey. She is below average in production, but better than the animals in Figs. 45 and 46.

transmitted by both parents, thereby insuring its purity and making certain its presence or appearance in the progeny. Inbreeding does not, therefore, create objectionable characters as is the opinion of many breeders; it merely provides an ideal method for their appearance when they are already present.

In the hands of the skillful breeder, inbreeding is a valuable tool. The capable dairyman will, of course, first analyze his herd to determine if any objectionable recessive characters

are present in the germ plasm; if they are, he will probably abandon the use of inbreeding. If, on the other hand, his herd is free of such qualities, he can resort to inbreeding to concentrate and purify the desirable characters in his herd, thereby insuring truer-breeding animals that produce less variable and more valuable offspring. Most of the best herds of dairy cattle have been produced by a liberal use of this form of breeding.



FIG. 45. SECOND GENERATION FROM CROSSBRED PARENTS

This cow is a second generation animal from a Holstein-Guernsey cross. She has poor conformation, is low in yield of milk, but does possess a relatively high butterfat test.

D. Examine the results of crossing breeds. In certain sections of the United States, notably New England, a demand on the part of milk companies for a higher fat content has induced breeders to attempt a short cut in breeding by mating high fat-test breeds, such as the Jersey or Guernsey, to the Holstein. By such a method they have hoped to get progeny that test on the average much higher than the lower-testing parent.

In the earlier sections of this chapter, we learned that, on the average, the progeny of such matings would be expected to possess a percentage of fat content in their milk essentially midway between that found for their parents. In other words, if a Guernsey sire which, when mated to other Guernsey cows, transmits a test of 5 per cent fat to his progeny is mated to Holstein cows whose average test is 3 per cent, such a sire is expected then to produce crossbred daughters that test 4 per cent fat.

This expectation is, on the average, true; and the first-generation progeny of such a cross, if their parents are good, make good cattle and test approximately 4 to 4.25 per cent fat. In order to benefit by the process, however, it is necessary to perpetuate further these hybrids or crossbreds. Such animals are highly variable genetically; and their progeny, whether as the result of mating to a brother or backcrossing to either parental breed, are likewise extremely variable. The photographs, Figs. 44, 45, and 46 indicate the variability in appearance of second-generation progeny from a Holstein-Guernsey cross. This system of breeding is never practical when purebred parents are used and is seldom desirable where grades are used because of the highly variable nature of the second- and third-generation progeny.

To attain the same objective, it is generally more desirable to use the two methods of selection A and B, already discussed, and gradually develop the character sought. This method of selecting for a given character has been used frequently for these purposes and has been proven effective.

4. STUDY THE SIRE PROBLEM

The problem of breeding good useful cattle is essentially the problem of selecting good sires. The germ plasm of the sire is repeated in the herd every time a daughter is born. This ordinarily means in two years' service in the average herd essentially as many daughters will be born as there are cows

in the herd. In other words, his influence genetically is equivalent to the combined influence of all of the cows. This fact makes his selection an important and critical problem and one that should be given careful thought and study.

Procedure:

- A. The sire and variance.
- B. The proven sire.
- C. Methods of proof.
- D. Choosing a proven sire.
- E. The young sire.
- F. The pedigree—its use and abuse.
- G. Estimating the genetic value of a young bull.
- H. Sampling the young sire.
- I. Extending the use of sires.

A. The sire and variance. In our discussion of the sire problem, we should introduce a new term, homozygous. In animal breeding this term, when applied to a single character or a large group of characters, signifies that it or they are formed by the union of two or more genes of the same type received from both parents. It is not important whether the character is in the dominant or recessive condition; the animal is, in such cases, pure for the character or characters and breeds true to type. In other words, it can transmit nothing but the characters.

It is inconceivable that any animal could be homozygous for every character that it possesses. Some sires are more homozygous than others and produce more uniform progeny with less variance from type, their type. This is a highly important point in sire selection. The more homozygous a sire is, other factors being the same, the more uniform will be his progeny. This quality of being homozygous is, of course, best determined by testing the sire for both the level and uniformity with which he transmits his qualities.

B. The proven sire. It is generally conceded that the purchase of a tried sire affords the least risk to the purchaser.

By a tried sire is meant one whose daughters have already proved their value as producers of milk and fat. A tried sire might be, of course, one whose daughters were decidedly inferior, but such a sire, although his daughters might have been tested for production, would have no place in a good breeder's herd.

In addition to the evidence on production, one can, by com-

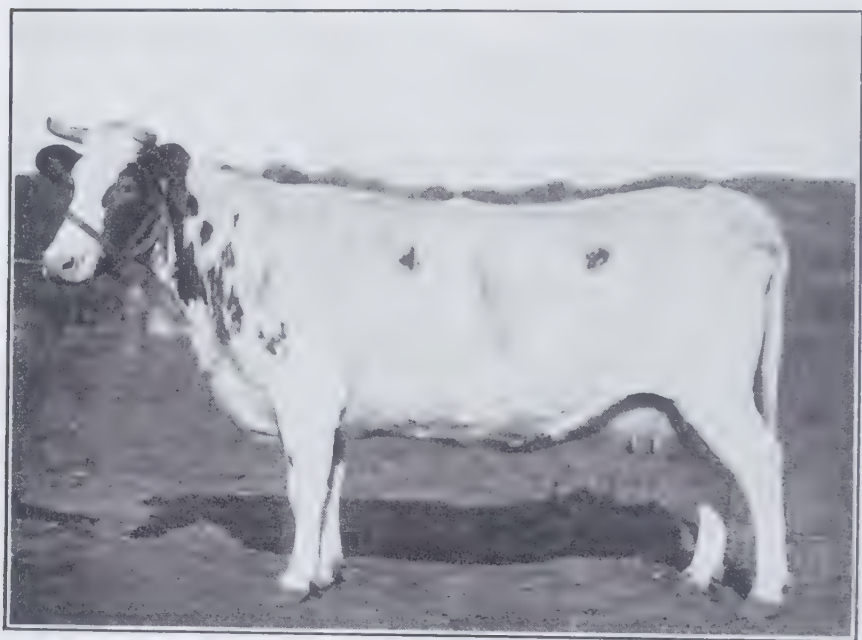


FIG. 46. SECOND GENERATION FROM HOLSTEIN-Guernsey CROSS

This animal possesses more of the characteristics of an Ayrshire than either of the parental breeds. She clearly illustrates the variability in second-generation cross-breeds and demonstrates the difficulty of perpetuating desirable animals when breeds are crossed.

paring the individuality of the daughters of such a sire with that of their dams (or mothers), judge to what extent the sire has influenced the conformation or type of his daughters. A breeder is regarded as fortunate when he is able to locate a good, healthy, tried sire at a reasonable price.

C. Methods of proof. Since a sire does not yield a product whereby his transmitting ability can be directly evaluated,

his genetic value or ability to transmit milk and butterfat must be determined indirectly by testing his offspring. This complicates the problem of testing because the dam also contributes to the productive capacity of the progeny. It is generally assumed that the sire and dam contribute equally to their offspring; therefore, one-half the influence is credited to the sire. This fact serves as the basis for most of the methods used in evaluating the transmitting ability of a dairy bull.

The simplest method for determining the transmitting ability of a sire is to obtain the average production of all his tested daughters and consider that value his transmitting ability. Certain of the breed associations calculate the index of their sires on this basis and publish a list of sires with ratings determined in this way. A leading advantage of this method is that every sire with the required number of daughters (usually ten) can be given a rating. The principal disadvantage is that the method takes no account of the influence of the dam on the production of her daughters.

Even those who favor the above method of rating sires because of its simplicity concede that better accuracy is obtained and a more dependable rating given when the transmitting ability of the dam is also considered. A very satisfactory method for accomplishing this purpose is to use the following formula:

$$X = 2\bar{O} - D$$

In this case:

X = sire's transmitting ability

O = production of daughters (offspring) in pounds of milk or butterfat

D = record of dam in pounds of milk or butterfat.

Production records for daughters and dams should be considered at the same age or corrected for age.

D. Choosing a proven sire. Proven sires are five or more years of age when obtained. Although the advantages of

having a sire of known transmitting ability may be well understood, certain precautions must be taken in the purchase of such animals. In all instances, tried sires are mature and usually large in size, have bad dispositions, and are difficult to handle. It is highly desirable to provide suitable quarters where the bull may be kept without frequent handling or danger to attendants. A pen suitable for this purpose is described in Chapter XIV. Make this an established rule in handling bulls: Never take any chances with a bull after he is one year old, no matter how quiet or docile he may appear to be.

In buying a mature bull, be especially careful to deal with a reputable owner and obtain a guarantee (preferably written) that the animal is a breeder. Older bulls should be shipped only when absolutely necessary, as shipment, even for short distances, may put the animal out of service for from two to six months.

The relation of the sire to the spread of infectious diseases is not well known. It is, however, highly desirable before purchase to have the animal tested for tuberculosis, infectious abortion, and trichomonas. If the animal reacts to any of these tests, he should not be purchased for use in a healthy herd. Health has been mentioned first in choosing a proven sire because diseased animals, regardless of how desirable they might otherwise be, almost never prove valuable or satisfactory additions to the herd.

A good proven sire should have a minimum of six tested daughters, and these should be uniform in appearance and production. Too frequently a sire is selected on the basis of one or two high-record daughters without regard to the production of the remainder of his daughters. This is not a dependable practice. Furthermore, the daughters should be unselected. In other words, all the daughters should be tested and considered as they come into milk. If the first six or, better yet, the first ten daughters of a given bull are tested and none omitted, then one has a fairly dependable sample

of the daughters, and a good deal of knowledge regarding the transmitting ability of the sire can be obtained in this way.

E. The young sire. No matter how greatly dairymen might wish to use tried sires, the great majority will always be required to depend upon the service of young, unproven bulls for the development of their herds. It is, therefore, extremely important to study carefully the qualities that are significant in the selection of a young bull, because the fewer the mistakes made in choosing young bulls, the higher will be the percentage of successfully proven bulls when these young bulls become old enough to have their daughters tested.

Bulls and cows that are homozygous (pure) for a large majority of their characters make the best parents for young sires. It is of course understood that such parents must not only be genetically pure for the characters that they possess, but they must possess desirable qualities. Information on this point is gained quite largely by studying the characteristics of the ancestors of the individual.

F. The pedigree—its use and abuse. A pedigree is a record of the parentage or ancestry of an individual. The basic portion of a pedigree records the name and number of each individual in the ancestry. Such information is valuable insofar as it identifies the parents, but is not particularly useful in determining the genetic qualities of an animal except when the parents are well-known and their achievements widely recognized. For the average pedigree to be useful in the selection of a young bull, information that bears directly upon the problem is highly desirable. Breeders and pedigree companies, recognizing the necessity of having much supplementary material displayed in the pedigree, frequently incorporate irrelevant information that does give the pedigree a good general appearance but is not of any particular use in determining the breeding value of the animal.

The first pedigree is a good example of one that contains much useful information to guide a person in determining the ability of the ancestors of the animal to produce milk and

Pedigree of COLONY MIRANDA Koba ROMEC

H. B. No.

Tag 1523

Born: 7-3-37

Sir Romeo Mildred Colantha 6th, 70275 Extra Class in Advanced Registry, 112 daughters have 241 records (305 and days). They average, every daughter and record included: M. 17741 F. 601 %. 3.44	Sir Romeo Mildred Colantha, 53433 All-American, 1922 and 1923. 31 tested daughters, 4 proven sons. Sire of: Carnation Romeo Inka Bracelet, M. 30252.0 F. 968.8	Sir Romeo Fayne, 34334 24 tested daughters, 10 proven sons. Sire of: Susie Aaggie Dekol, 3 yr. M. 25167 F. 1004 Mildred Colantha, 23759 3 tested daughters, 1 proven son. By a brother to: Homestead Susie Colantha, M. 28361 F. 890
Hazelwood Ormsby Korndyke Dekol (290090 AHB) 2 tested daughters, 3 proven sons. Dam of: Carnation Walker Hazelwood, 2 yr. M. 25532 F. 976. "World's Record for Age." 4 yr., 6 mo. M. 29082 F. 1198	Hazelwood Ormsby Korndyke Dekol (290090 AHB) 2 tested daughters, 3 proven sons. Dam of: Carnation Walker Hazelwood, 2 yr. M. 25532 F. 976. "World's Record for Age." 4 yr., 6 mo. M. 29082 F. 1198	Hazelwood Posch Ormsby (64222 AHB) 4 tested daughters, 4 proven sons. Sire of: Idaho Violet Posch Ormsby, M. 26812 F. 1007 Miss Korndyke Dekol Ormsby (109165 AHB) M. 459.4. Butter 16.9, 7-day test. 1 tested daughter. Sister to: Miss Korndyke Grace Ormsby, M. 481.0. Butter 30.3, 7-day test.
Colony Miranda Koba Heilo, 233813 Gold Medal in Advanced Registry, 2 R.O.P. records average: M. 22531 F. 767. Lifetime record—3 records total 60675 lb. of milk. Dam of: Colony Miranda Koba Colantha 306185 365 d. at 2 yr. M. 21126 F. 684 Special: This daughter is full sister to Colony Miranda Koba Romeo.	Hazelwood Heilo Sir Bessie, 66155 CHB Extra in Advanced Registry. Sire of 112 daughters who have completed 216 (305 and 365 1) records which average: M. 16316 F. 558. On 96 daughter-dam pairs he was given an index of: M. 18139 F. 612. Sire of: Colony Fleta Heilo, Canadian Champion for Milk Production with: M. 34636 F. 1156	Hazelwood Heilo Butter King (351076 AHB) 17 daughters have 28 records. Average M. 17744.0 F. 571.0. Fayne Pietertje Bessie (567678 AHB) No year records. A sister: Modest Pietertje Fayne, 4 yr. M. 16556.0 F. 501.0
Colony Miranda Koba Colantha 306185 365 d. at 2 yr. M. 21126 F. 684 Special: This daughter is full sister to Colony Miranda Koba Romeo.	Colony Miranda Koba, 118087 (twin) Gold Medal in Advanced Registry. 2 R.O.P. records average: M. 18631 F. 654. Lifetime record—8 records total 135059 lb. of milk. 3 daughters (full sisters) have 8 records (6 are R.O.P.), average: M. 16404 F. 559. 4 daughters (full sisters) have 10 records (all R.O.P.); they average: M. 18621 F. 632. 5th daughter (full sister to above 4) just completed record not yet reported.	Colony Koba McKinley, 31520 Extra Class in Advanced Registry. 72 daughters have 146 records (305 and 365 days). Average with every daughter and every record included: M. 15600 F. 534.7 Deirdre Doughlass Segis, 31842 Excellent in Advanced Registry. 2 R.O.P. records average, M. 20879 F. 725.0. Lifetime record—8 records (2 R.O.P.) total 146175 lb. 2 daughters' 9 records (3 R.O.P.) average M. 16835 F. 586

butterfat and to transmit that quality to their offspring. Such information is very valuable in selecting a young bull, and the breeder who has available animals with ancestors displaying so much production on both sides of the pedigree has a high probability of success in choosing his next sire.

The second pedigree is a very good example of an attempt to confuse the inexperienced breeder and make him feel that he has a good deal of information regarding the individual. Such information, however, is of little value because the animals and records mentioned are so distantly related to the bull in question that the probability of their influence on his germ plasm is relatively small. Whenever a pedigree is submitted to you for observation, be sure that the information relates directly to the animal in question and not to some relatively remote ancestor whose influence on the particular animal is of doubtful importance.

G. Estimating the genetic value of a young bull. The dairy industry will profit by any methods which can be used to estimate the genetic value of young bulls more correctly. The more accurately one is able to predict the probability of success, the less chance of failure there is in selecting such an individual. Wide experience and careful study of the genetic principles involved indicate that certain qualifications in the animal are important and should be carefully and rigidly adhered to in the choice of a young bull. Assuming that the sire and dam contribute equally to the genetic make-up of the individual, care must be exercised in evaluating the parents of the animal.

The dam should have a production record made under environmental conditions somewhat similar to those of the herd in which the bull is to be used. In fact, it is desirable for the dam to have not only one record available, but also records of each year's production so that the cumulative or total lifetime yield of the individual is known. Mothers of bulls who are consistent in production and calve regularly are better prospects than those with one large record and

failures in the majority of their lactations. The transmitting ability of the dam also is gauged to a large degree by the production of her daughters. It is highly desirable that the young bull have a sister, preferably a full sister, that has proven her value as a producer. If more than one sister is available, that, of course, is valuable additional information.

The sire of the calf should have at least six daughters that have been tested for production. These daughters should also be unselected. Not only should his daughters show a high average level of production, but they should also be good individuals that show promise of a relatively long productive life. If this sire is from a cow that has made a good productive record and has produced daughters that have proven themselves, the probability of success is increased.

In other words, in selecting a young bull, choose one whose ancestors have proven good for several generations and especially one whose dam and sire have both demonstrated their ability to transmit desirable dairy qualities. In order to have a more definite method for evaluating a young bull, the following plan has been developed. If a young bull has a score of 80 or more by this method, he should prove a desirable animal to test out in the herd.

H. Sampling the young sire. No matter how promising a young bull may be, as judged by his pedigree and his ancestry, he should not be used too extensively until his own transmitting ability has been determined by sampling his daughters. In order to do this properly, it is desirable for him to be mated to twenty to thirty cows. This should supply eight to fifteen daughters which, when tested for production, give a fairly representative and sufficiently dependable sample to indicate whether or not the bull should be continued in heavy service. Not only should these daughters show productive capacity, but they should also be the right kind of cattle, the kind that should continue in production for a relatively long and useful life, showing not only high yield but economical production as well. If it is neces-

METHOD FOR EVALUATING A YOUNG BULL

Points Considered		Total Points Points Allowed
<i>Sire</i>		
Proven production—with at least 6 daughters (chosen at random), <i>mature equivalent production</i> :		
Production, 450 pounds of fat.	5	
For each additional 50 pounds of fat.	5	
Maximum allowed.		30 _____
Type—if 60% of daughters classified with average:		
G.	5	
G+.	10	
Maximum allowed on individuality.		10 _____
His grand-sire-proven production, 10 daughters that average 500 pounds of fat or more.		5 _____
His sire's dam has 500 pounds mature equivalent record or better.		5 _____
<i>Dam</i>		
Production:		
Average mature equivalent production of 500 pounds.	5	
For each 50 pounds added.	5	
Maximum points allowed.		20 _____
Type:		
If classified G+.	5	
If classified very good.	10	
Maximum points allowed.		10 _____
Transmitting Ability:		
1 daughter, 500 pounds.	5	
2 or more daughters, 500 pounds of fat.	10	
Maximum points allowed.		10 _____
Ancestry of Sire:		
500 pounds average production 1 or more daughters.		5 _____
Ancestry of Dam:		
500 pounds mature equivalent production or above.		5 _____
Total points.		100 _____

sary to continue this bull in service and if his young daughters appear promising, it is far wiser to use him in another herd so that his influence, if not desirable, is not so extensive in a single herd.

I. Extending the use of sires. All sires that have proven good should be used extensively. This can be accomplished in two ways: first, by forming bull associations whereby the same bull is used in several herds, thereby making it unnecessary to practice intensive inbreeding and yet making it possible to practice line breeding. By this method, if proper precautions are taken to keep older bulls in service, good bulls can be given extensive use and their influence on the breed and industry materially increased.

A second method is one whereby outstanding sires can be given extensive use through artificial insemination. By this method a sire can have as many as 500 to 1000 or more daughters, and so very greatly increase the opportunity to extend superior germ plasm within the breed and industry.

Artificial insemination is relatively new but is gaining popularity rapidly, and it is quite probable that this method of reproduction will have more general and more extensive use in the future.

5. PLAN YOUR BREEDING PROGRAM

You are now in possession of the fundamental or basic knowledge for breeding good cattle. To do so in a minimum of time and without unnecessary mistakes, it is well to have a definite program, planned in advance. A generation in cattle represents three to four years, and one can ill afford to make unwise selections of animals or to use methods that would cause the loss of a generation of progress.

Procedure:

- A. Select a standard of production.
- B. Study variation from that standard.

- C. Purify desired characters.
- D. Introduce new characters from outside.
- E. Introduce new characters singly.

A. Select a standard of production. It is good practice in building a herd to set a minimum standard of production which cows must equal before they are permitted to remain in the herd. In herds that are well established and properly



FIG. 47. CROWD LISTENING TO A LECTURE ON BREEDING

This represents approximately half the group of interested breeders who were present to view a classification and get points on breeding better cattle.

managed, 300 pounds of fat is not too high a production to expect of the individual mature cow. Here again, however, it is necessary to exercise judgment for occasionally high-class animals, because of abortion or some other disease, may not reach that production. Young animals, such as heifers milking with first calves, would be expected to produce less, probably 200 to 225 pounds of fat. In taking a cow's record, it is advisable to consider the calendar year, from January 1

to December 31, for instance, instead of the lactation period, since the calendar year includes the dry period when there is a feed cost but no production to be considered.

B. Study variation from that standard. When the herd is highly variable and not more than half the animals average as well as the standard set, culling must be heavy and progress relatively slow. At such times it is probably advisable to sell undesirable animals for beef and use the money so obtained to purchase superior individuals. It is more desirable to purchase animals slightly below the average from a very uniform and good herd than to secure here and there an even superior animal from a highly variable herd, when the animal selected represents the best in the herd. Such animals seldom breed as good as they are, whereas animals below the average in a very good herd often breed better than they appear to be.

C. Purify desired characters. Your objective is to develop the genetic qualities you seek to establish and preserve them in a homozygous condition. To do this, you probably will want to use inbreeding. If no objectionable recessive characters appear, you will be fortunate and can use the method extensively.

D. Introduce new characters from outside. Even before you are satisfied with the uniformity of your herd, you may wish to effect improvement in certain qualities. Animals meeting your standards will need to be obtained by purchase. Care must be exercised to be reasonably sure, first, that the animals secured will breed true for the quality sought, and second, that you do not at the same time introduce an undesirable quality that you will be obliged ultimately to eliminate.

E. Introduce new characters singly. Some breeders attempt to incorporate a number of characters at one time and in a single animal. This sort of animal is seldom genetically pure enough to transmit all its characters uniformly. It is usually more advisable to introduce new characters one at a time.

In this way the character can be more carefully studied and is usually more effectively established and perpetuated.

6. FAMILIARIZE YOURSELF WITH THE TRENDS IN BREEDING CATTLE

It is not intended that this statement apply to fads or fancies that may have popular support but are not based upon sound value. In one country, for instance, color in Holsteins is given almost fifty out of a total of one hundred points in the score of the animal, although the percentage of white or black present has no correlation to productive capacity. What is meant here is fundamentally or basically important trends.

Procedure:

A. Study fundamental qualities.

B. Follow the policies of well-established successful breeders.

A. Study fundamental qualities. Always try to formulate a conception of the right kind of dairy cow. First of all, she must produce economically; then, she must have stamina to endure year-after-year production and reproduction. No other qualities can be substituted for these values.

B. Follow the policies of well-established successful breeders. Breeders of this type have studied their problems thoroughly. They have usually conferred extensively with their fellow breeders. They are not easily disturbed or confused by popular fads or fancies, and they understand the problems that confront them. A young breeder or dairyman is fortunate when he has such a breeder for a friend and adviser.

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CHAPTER VIII

FEEDING THE DAIRY COW DURING THE WINTER SEASON

High milk yields are largely dependent upon good methods of feeding and management. The feeding of dairy cows during the winter season offers so many problems that the dairy farmer should have a thorough understanding of the principles upon which good feeding practices are based, as well as a complete knowledge of the practices themselves.

Operations:

1. Considering the characteristics of an ideal ration.
2. Selecting suitable roughages.
3. Feeding roughages.
4. Selecting economical grains and supplements.
5. Calculating the formula for the grain mixture.
6. Grinding and mixing grains and supplements.
7. Feeding the grain mixture.
8. Providing an ample quantity of minerals.
9. Insuring an adequate vitamin intake.

1. CONSIDERING THE CHARACTERISTICS OF AN IDEAL RATION

No one feed that is now known completely fulfills the requirements of an ideal ration for milk production, but spring pastures come closest to approaching the ideal. Since fresh, green pasture grass is so valuable a feed, some of its characteristics should be considered desirable in rations fed during the winter season.

Characteristics considered:

- A. Furnishes good palatability.
- B. Provides suitable variety.
- C. Insures high digestibility.
- D. Contains some succulent feed.
- E. Produces a slightly laxative effect.
- F. Provides suitable bulk.
- G. Contains adequate amounts of protein.
- H. Exerts good effects upon flavor and composition of milk.
- I. Is economical.

A. Furnishes good palatability. Fresh, green pasture grass is the most palatable of all feeds for dairy cows. There is a close relation between the palatability of a feed or ration and the amount consumed. It is often difficult to obtain palatability in the winter ration, but it may be provided to some degree in several different ways: (1) by using succulent feeds, such as silage and roots; (2) by using only those feeds which have a pleasant odor and flavor; and (3) by using a number of different feeds in the concentrate mixture; and (4) by feeding two or more kinds of roughage. Moldy or damaged feeds are low in palatability, as are most feeds extremely high in fiber content, such as the coarse parts of corn-stalks, soybean hay, and other coarse-stemmed plants.

B. Provides suitable variety. The inclusion in the ration of a number of feeds from different plants helps to provide a suitable assortment of amino acids and thus tends to prevent deficiencies in the quality of the protein furnished by the ration. In the same manner, a variety of feeds is likely to furnish the needed kinds of minerals and vitamins. To insure a satisfactory degree of variety in the ration, a good rule to follow is: The ration should contain feeds from at least four different plants; one of the feeds should be a legume roughage, and each of the feeds should form an effective portion of the ration.

A ration made up of corn-and-cob meal, corn-gluten feed, ground oats, corn silage, and corn stover would be likely

to prove unsatisfactory if fed over a considerable period. On the other hand, a ration containing corn-and-cob meal, ground oats, wheat bran, ground soybeans, alfalfa hay, and corn silage may be expected to give excellent results.

C. Insures high digestibility. Pasture grass is much more completely digested when it is young and tender than after it becomes mature. Carefully cured hay is nearly as digestible as the grass from which it was made; but hay, cured by careless methods, in which the leaves and finer parts of the



FIG. 48. AMPLE FEED STORAGE MAKES POSSIBLE THE FEEDING OF GOOD RATIONS IN WINTER

High-quality roughages, including silage and legume hays, form the basis of economical rations for dairy cows. This attractive barn with connecting silos provides an efficient unit for winter milk production.

stems are lost, or hay that has been leached by rain, is much less digestible.

Sixty-five to 90 per cent of the dry matter of cereal grains and grain by-products is digestible, but only 50 to 70 per cent of the dry matter of high-grade roughages is digestible. Some roughages that are very high in fiber content and low in other digestible nutrients, such as the straws of the cereals and the hulls of various seeds, have so little food value that they should be given little place in the ration of the dairy cow in milk. If high production is expected, a dairy cow

must not be forced to eat large quantities of such feeds. Other roughages high in fiber, such as well-cured corn stover, make good supplements to legume hays and fill an important place as feeds for dry cows.

D. Contains some succulent feed. One of the characteristic and valuable features of fresh pasture grass is its succulence. Succulent feeds stimulate the appetite and also have a slightly laxative effect upon the digestive tract, both valuable features of a ration. Pasture grass, corn silage, soiling crops, and roots are the common succulent feeds, silage being the most common and usually the most economical for winter feeding.

It is well known that high milk production per cow may be obtained on rations containing no succulent feed. This is particularly applicable to rations containing high-quality alfalfa or other legume hay. Several agricultural experiment stations have demonstrated that cows fed rations which include some succulent feed, such as silage or soaked beet pulp, produced no more milk than comparable groups of cows fed the same feeds in dry condition. It is believed, however, that, when cows are fed roughages which are not of the highest quality, the inclusion of a succulent feed in the ration helps to maintain the level of feed consumption. On many dairy farms it is customary to feed the hay grown on the farm, and if this is of poor quality, a condition that often occurs when rains are frequent during haymaking, the addition of silage to the ration not only increases the consumption of roughage but may also considerably enhance the intake of vitamins in which the dry roughage may be low.

E. Produces a slightly laxative effect. The best rations for milk production are those which have a slightly laxative effect. Some feeds that produce this effect are the succulent feeds, legume hays, linseed meal, wheat bran, and molasses. Most feeds that are high in fiber, with the exception of the legume hays, tend to constipate dairy cows.

F. Provides suitable bulk. Pasture grass and other roughages are bulky in proportion to their weight and nutritive

content. They occupy much space in the stomach, and for this reason cows fed only roughages may not receive enough digestible nutrients to support high milk yields. Careful consideration must be given to the selection of feeds for the ration, therefore, to make certain that sufficient nutrients are supplied in quantities of feeds that will readily be consumed.

Very often in the early part of the pasture season cows consume so much watery pasture grass that they do not care for grain and do not obtain sufficient nutrients from the grass to support their production. Under such conditions the hours at pasture may be limited so that they will eat some grain mixture. It should be emphasized, however, that rations for dairy cows should always contain as much roughage as it is possible to supply in well-balanced rations, because roughage is the main source of mineral matter and vitamins and usually is also the most economical source of nutrients.

It was formerly thought that grain mixtures for dairy cows should be very bulky. Experiments at the University of Illinois¹ showed that when a dairy cow swallows grain mixture it is mixed almost immediately with the roughage and other rumen contents. By means of moving pictures taken within the rumen, the Ohio Agricultural Experiment Station showed that the muscles of the rumen are in constant action exerting a churning motion which thoroughly mixes the contents in this organ. These findings indicate that the need for bulky grain mixtures has been overemphasized and that the main point to be considered is that the principal need for bulky feeds in the grain mixture may be to insure palatability. Heavy grain mixtures that are readily consumed are usually satisfactory provided all the other requisites of an ideal ration are met.

G. Contains adequate amounts of protein. When the amount of protein in the ration is too small, either the protein of the

¹ W. B. Nevins. Effects of Fasting and the Method of Preparation of Feed upon the Digestive Process in Dairy Cattle. Jour. Agr. Res. 36, 777, 1928.

body tissues is drawn upon to supply protein for the milk, or the milk flow drops to the level of the amount of protein fed. When too small a proportion of protein is fed, the excess carbohydrates and fat, which normally should be used for milk production, must go for the construction of body tissue. An excess of protein, on the other hand, is no more valuable than the same amount of carbohydrates; and since protein is usually the most expensive constituent of the ration, it is wasteful to feed more than is needed. Too small a proportion of protein in the ration is one of the greatest causes of failure to obtain greater milk production and probably larger profits, particularly on farms where large amounts of low-protein feeds, such as corn, corn stover, corn silage, oats and grass hays are fed to the dairy herd.

H. Exerts good effects upon flavor and composition of milk.

Good flavor in milk is possible only when suitable feeds are supplied to the cows. Objectionable flavors are produced in milk when cows graze pastures containing wild onions, wild garlic, and rape. Strong-smelling feeds, such as cabbage and turnips, poor-quality legume silage, and many weeds, including ragweeds, also produce undesirable flavors in milk and cream. When such feeds must be used, they should be given at once after milking and the cows kept from them for six to eight hours before milking.

Sudden changes in the kinds of feeds fed or quickly changing from barn feeding to pasture may cause indigestion, diarrhoea, and bad flavors in the milk.

Well-flavored milk requires the use of pastures free from objectionable weeds, the careful selection of well-cured roughages, and concentrates in good condition. Even feeds considered suitable for some classes of livestock, for example, fish meal and tankage, may not be suitable in the feeding of dairy cows for the production of well-flavored milk.

I. Is economical. The final and often the deciding factor in the selection of a suitable ration is the cost, for some of the most desirable feeds sometimes should be omitted from the

ration on account of their high price, when other cheaper feeds may be substituted satisfactorily. The cost of feed usually makes up 50 to 60 per cent of the total cost of milk production.

The market prices of feeds change frequently, giving an opportunity for the exercise of business judgment in the selection of economical feeds. Digestible nutrients are usually obtained most cheaply in unmarketable roughage, such as



FIG. 49. ALFALFA HAY IS ONE OF THE BEST ROUGHAGES FOR WINTER FEEDING

Well-cured alfalfa hay is generally preferred by dairy farmers as roughage for winter feeding. It is superior to other legume hays in lime content, in palatability, and in its all-around feeding value. The replacement of non-legume roughage by high-quality alfalfa hay is probably the greatest single improvement that can be made in the winter feeding of dairy cows.

corn stover and the lower grades of hay. There is not a wide difference in the cost of digestible nutrients in marketable roughage and concentrates, the cost of nutrients in purchased hay sometimes exceeding that of concentrates. The concentrates that contain high percentages of protein, such as soybean oilmeal, cottonseed meal, gluten meal, peanut oilmeal, soybean seed, etc., usually furnish digestible protein at a lower cost per pound than feeds low in protein, such as corn, oats, and barley.

2. SELECTING SUITABLE ROUGHAGES

There are great differences between feeds with respect to their value for milk production as well as their market prices. Opportunity to exercise good judgment and business ability is presented in the selection of the most desirable feeds.

It is generally found more economical to use the feeds produced on the farm than to sell them and to purchase others in their places. This may not be true, however, if the roughages on hand consist only of non-legume hay, such as timothy or redtop. If the non-legume hay can be marketed and good legume hay purchased in its place at about the same price per ton, it is usually a profitable procedure to make the exchange. The labor involved in the transaction must be considered as one of the deciding factors as to whether or not the exchange should be made. Should it not seem feasible to exchange all the non-legume hay for legume hay, there may be an advantage in exchanging about one-half the hay, so that at least one feed of legume hay may be given daily. Such an arrangement very greatly improves the ration as compared with straight non-legume feeding, especially if the herd is capable of high production.

When good-quality legume silage is fed liberally, it is not so necessary that legume hay be fed, although it will be found that in almost every phase of dairy-cattle feeding the more high-quality legume roughage that is fed, the more satisfactory the results.

3. FEEDING ROUGHAGES

The roughage portion of the ration (1) provides most of the vitamins; (2) supplies a large part of the lime; and (3) when of proper kind and quality, furnishes laxative properties and other attributes that keep cattle in a healthy condition. Because it has these functions, roughage may be said to be the protective part of the ration. It is usually a more economical source of nutrients than the concentrates. Hence,

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it is good feeding practice to supply dairy cows with all the good-quality roughage they will consume without undue waste, and then, if needed, supply a suitable grain mixture in addition.

Procedure:

- A. Feed hay freely.
- B. Feed silage as supplement to hay.
- C. Feed roughages other than hay and silage judiciously.

A. Feed hay freely. The best plan is to feed all the hay the cows will consume readily, although if hay is extremely high in price and must be purchased, it may be desirable to limit the amount.

After milking is finished, feed hay to the cows. As a rule, feed good-quality hay in equal amounts morning and evening. In the case of hay with coarse stems, or of hay that is not of the best quality, feed the greater portion of the day's allowance in the evening, so that the cows will have a longer time to pick the hay over. Do not feed good-quality hay in such large amounts that part of it remains in the manger several hours for the cows to nose about. To get the cows to eat as much hay as possible, feed it in smaller amounts three times a day and reduce the amount of silage or other roughage. Likewise, keep the mangers free from refused stems and other refuse, so that fresh feed placed in the manger will not soon become stale and unpalatable as a result of being mixed with rancid or moldy refuse.

Sometimes one has on hand two or more kinds of hay differing in feeding value. For example, suppose there is on hand 1 ton of alfalfa hay to every 3 tons of mixed clover and timothy hay. Do not feed the cows on the alfalfa alone until the supply is exhausted, but give a small feed of the alfalfa hay in the morning and then a very liberal feed of the clover and timothy in the evening.

B. Feed silage as supplement to hay. In no event should so much silage be fed that it prevents the cows from eating

hay freely. Even when legume or grass silage is fed, it is best that some dry hay be consumed in addition.

Good-quality corn silage is usually fed at the rate of 3 pounds daily for each 100 pounds of live weight, or 25 to 40 pounds per cow daily. Legume or grass silage may be fed in somewhat larger amounts than corn silage since it contains from 10 to 20 per cent less digestible nutrients in 100 pounds than corn silage. Fed at these rates, the day's feed may be divided into two equal portions, one being fed in the morning



FIG. 50. HARVESTING SOYBEANS FOR HAY WITH A BINDER

This heavy crop of soybeans stood up so well that it was possible to harvest it with a grain binder. Placed in long shocks, the bundles cure out quickly. Very often the crop becomes lodged and tangled so badly that harvesting is best carried out by mowing, raking, and allowing the soybeans to remain in large loose shocks for one to two weeks. Well-cured soybean hay is a valuable roughage for winter feeding, but usually the coarse stems are not completely consumed, and this results in a waste of 10 per cent or more of the weight of the hay fed.

and the other in the afternoon or evening. Because of the effect of silage on the flavor of milk, feed silage only after milking or not less than three to four hours before milking.

Small amounts of frozen silage are not injurious, but if fed in large amounts or over a period of several days, it is likely to cause indigestion and scours. When the silage next the wall of the silo freezes solid, it is usually necessary to leave this until the weather becomes mild enough for the silage to thaw. This may be fed safely if fed within a few days after it thaws. If a large amount of frozen silage next the walls has been

left exposed, discard all moldy or decayed portions before feeding.

C. Feed roughages other than hay and silage judiciously. Such feeds as **corn stover**, **kafir**, and **sorghum cane** may be utilized to advantage if it is understood that they can not take the place of legume hay. Feeds such as corn stover and sorghum are low in protein and only a small part of the amount fed is eaten. Hence, legume hay should be fed in addition.

Shredded stover and **chopped** or **ground roughage** are best fed in the barn since these feeds blow about if fed outdoors. Uncut stover is advantageously fed in outdoor racks from which the refused portions are more readily removed than from indoor mangers.

Do not pasture milking cows in **standing cornstalks** from which the ears have been removed, during cold, inclement weather, or after the best part of the feed has been obtained. Corn stover is at best a feed low in nutritive value, and becomes less valuable as the rains leach the nutrients from the leaves. It is doubtful, if, under most conditions, the cows obtain enough feed to offset the effects of excessive exercise and exposure.

Mangels, **rutabagas**, and **pumpkins** should be prepared for feeding by slicing with a knife or power root slicer. Remove any rotten portions with a large knife. Feed roots or pumpkins in the same amounts as corn silage. Place them in the bottom of the manger, as with silage, and empty the concentrate mixture over them.

4. SELECTING ECONOMICAL GRAINS AND SUPPLEMENTS

The market prices of farm grains and protein supplements change from season to season and not infrequently from day to day. Occasionally marked savings in the cost of the grain mixture may be made by a study of feed market prices and by changing the grain mixture to take advantage of the cheaper feeds.

Obtain the prices of feeds at your local feed store and consult Table XXIV for the amounts of total protein and total digestible nutrients in these feeds. Construct a table similar to Table XX, using any home-grown feeds as well

TABLE XX

SIMPLE METHOD FOR COMPUTING RELATIVE COSTS OF PROTEIN AND DIGESTIBLE NUTRIENTS IN FEEDS

Feed	Price per Bu. or Ton	Weight per Bu. or Ton, Pounds	Value of 100 Lbs. of Feed*	Total Protein in 100 Lbs., Pounds	Total Digestible Nutrients in 100 Lbs., Pounds	Cost of 100 Lbs.	
						Total Protein	Total Digestible Nutrients
Barley.....	\$.84	48	\$1.87	11	79	\$17.00	\$2.37
Corn, shelled.....	.80	56	1.55	9	80	17.22	1.94
Corn, ear.....	.80	70	1.26	8	64	15.75	1.97
Soybeans.....	1.05	60	1.87	37	86	5.05	2.02
Soybean oilmeal...	40.00	2000	2.00	41	81	4.88	2.47
Linseed meal.....	45.00	2000	2.25	37	76	6.08	2.96

* After calculating the value of 100 pounds of feed, 12 cents per 100 pounds is added to cover cost of grinding.

as commercial protein supplements, and fill in the first five columns. Compute the results for the last three columns as follows:

The cost of 100 lb. of barley is $\frac{\$.84}{48} \times 100 = \$1.75$.

Adding 12¢ for grinding gives \$1.87.

Cost of 100 lb. of total protein in barley is $\frac{\$.187}{11} \times 100 = \$17.00$.

Cost of 100 lb. of total digestible nutrients is $\frac{\$.187}{79} \times 100 = \$2.37$.

After completing the table, it is probably evident that some of your available feeds are much cheaper sources of nutrients than others. At the prices given in Table XX, barley is a more expensive source of total digestible nutrients than corn; soybeans are slightly more expensive than soybean oilmeal as a source of protein, but supply total digestible nutrients somewhat cheaper than soybean oilmeal; soybeans and soybean oilmeal furnish both classes of nutrients more cheaply than

linseed meal. Because of the frequent changes in feed prices, one should recalculate the costs of nutrients each time feed is purchased.

5. CALCULATING THE FORMULA FOR THE GRAIN MIXTURE

When you have determined the cost of nutrients in the available feeds, the next step is to make up a formula for the grain mixture.

Procedure:

- A. Determine percentage of protein needed.
- B. Calculate a formula.
- C. Determine cost of mixture.
- D. Study typical formulas.

A. Determine percentage of protein needed. Successful preparation of grain mixtures depends in large measure on the ability of the feeder to judge the quality of the roughage fed and then to make up a grain mixture which will properly supplement that particular kind and quality of roughage.

Use the following guides in determining the percentage of protein needed in the grain mixture:

1. When the roughage consists of legume hay or legume silage only (that is, when no corn silage, corn stover, or grass hays are fed), the grain mixture should contain 12 to 14 per cent total protein.

2. When the roughage consists of legume hay, together with corn silage or corn stover, or when mixed hay alone is fed, the grain mixture should contain 14.1 to 16 per cent total protein.

3. When the roughage is all non-legume, such as timothy, redtop, millet, Sudan grass, corn silage and stover, the grain mixture should contain 16.1 to 20 per cent total protein.

4. When the roughage is of excellent quality, the lower percentage of protein in each case is used, but if the roughage is weathered, has few leaves, or contains a large proportion of weeds, the higher figure should be used.

5. When the roughage is definitely known to be of high quality and

is fed in unusually large amounts, the grain mixture may safely contain slightly less protein than specified in these rules.

Example: Suppose that medium-quality red clover hay and medium-quality corn silage, together with shelled corn and oats, are on hand. With this partly legume and partly non-legume roughage, a grain mixture containing 14 to 16 per cent total protein is needed; and since the roughage is of medium quality, about 15 per cent total protein will be right.

B. Calculate a formula. In planning the grain mixture to supply the needed amount of protein, it is usually best to keep in mind the kinds and amounts of home-grown feed on hand and to calculate a mixture that will, so far as possible, use the feeds in these proportions. Thus, if the amount of oats (in pounds) is only two-thirds the amount of corn (in pounds), a mixture might be made up to contain 3 parts corn to 2 parts oats.

Corn and oats will not make a mixture containing 15 per cent total protein, for shelled corn contains only 9 per cent total protein and oats only 12 per cent (see Table XXIV). Therefore a feed or feeds with higher percentage of protein must be added to the corn and oats. Suppose cottonseed meal and wheat bran are added to the mixture in the following proportions:

Feed	Amount of Feed, Pounds	Total Protein	
		In 100 Pounds of Feed, Pounds	In Amount of Feed Used in Mixture, Pounds
Ground shelled corn.....	300	9	27
Ground oats.....	200	12	24
Wheat bran.....	200	15	30
Cottonseed meal.....	50	41	20.5
	750		101.5

Then $\frac{101.5}{750} \times 100 = 13.5$, the percentage of total protein in the mixture. In order to raise the percentage of protein in the mixture to about 15 per cent, more cottonseed meal should be added. When the amount of cottonseed meal is increased to 100 pounds, the mixture then weighs 800 pounds and contains 122 pounds of total protein.

$$\frac{122}{800} \times 100 = 15.2, \text{ per cent total protein.}$$

This meets the requirements satisfactorily, as a supplement to the medium-quality part-legume roughage.

C. Determine cost of mixture. The cost of the mixture per ton may readily be computed according to the prevailing prices of feeds. If the prices were: shelled corn, 60 cents a bushel; oats, 42 cents a bushel; wheat bran, \$28 a ton; cottonseed meal, \$38 a ton, the cost of the mixture would be as follows:

Shelled corn: $60 \div 56$ (lb. per bu.) $\times 300$	\$ 3.21
Oats: $\$.42 \div 32$ (lb. per bu.) $\times 200$	2.62
Wheat bran: $\$28 \div 2000$ (lb. per ton) $\times 200$	2.80
Cottonseed meal: $\$38 \div 2000$ (lb. per ton) $\times 100$	1.90
Grinding 500 lb. corn and oats @ 12¢ per cwt.	.60
Total cost for 800 pounds of mixture.	<u>\$11.13</u>

$$\frac{\$11.13}{800} \times 2000 = \$27.82, \text{ the cost per ton.}$$

D. Study typical formulas. The formulas given below are typical of ones that are suitable for farms where one or more feeds are home-grown. Many dairy farmers throughout the Middle West have found formulas such as these satisfactory and economical. Study these formulas and note: (1) the number of feeds used in each; (2) the amounts of protein supplements required in formulas Nos. 13 to 18 as compared with the amounts in Nos. 1 to 6; (3) the recommended amounts of salt and bonemeal; (4) the possible substitutions that may be made in the formulas.

CALCULATING THE FORMULA FOR GRAIN MIXTURE 157

GRAIN MIXTURES CONTAINING ABOUT 13 PER CENT TOTAL PROTEIN *

No. 1

	lb.
Ground corn.....	585
Ground oats.....	300
Ground soybeans or linseed meal	100
Salt.....	15

No. 3

Ground corn.....	400
Ground oats.....	310
Wheat bran.....	200
Ground soybeans or linseed meal	75
Salt.....	15

No. 5

Ground corn.....	610
Wheat bran.....	300
Soybean oilmeal or cottonseed meal.....	75

No. 2

	lb.
Ground corn.....	685
Wheat bran.....	200
Ground soybeans or linseed meal	100
Salt.....	15

No. 4

Ground corn.....	500
Ground oats.....	410
Soybean oilmeal or cottonseed meal.....	75
Salt.....	15

No. 6

Ground corn.....	350
Ground oats.....	335
Wheat bran.....	300
Salt.....	15

GRAIN MIXTURES CONTAINING ABOUT 15 PER CENT TOTAL PROTEIN

No. 7

	lb.
Ground corn.....	450
Ground oats.....	335
Ground soybeans or linseed meal	200
Salt.....	15

No. 9

Ground corn.....	300
Ground oats.....	235
Wheat bran.....	300
Ground soybeans or linseed meal	150
Salt.....	15

No. 11

Ground corn.....	585
Wheat bran.....	225
Soybean oilmeal or mixture of soybean oilmeal and cottonseed meal.....	200
Salt.....	15

No. 8

	lb.
Ground corn.....	585
Wheat bran.....	200
Ground soybeans or linseed meal	200
Salt.....	15

No. 10

Ground corn.....	500
Ground oats.....	310
Soybean oilmeal or mixture of soybean oilmeal or cottonseed meal.....	175
Salt.....	15

No. 12

Ground corn.....	610
Wheat bran.....	150
Cottonseed meal.....	75
Ground soybeans or linseed meal	150
Salt.....	15

* See note regarding possible substitutions of feeds in formulas, and also acknowledgment following formula 18.

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GRAIN MIXTURES CONTAINING ABOUT 18 PER CENT TOTAL PROTEIN

No. 13		No. 14	
	lb.		lb.
Ground corn.....	400	Ground corn.....	425
Ground oats.....	250	Wheat bran.....	250
Ground soybeans or mixture of ground soybeans and linseed meal.....	325	Ground soybeans or mixture of ground soybeans and linseed meal.....	300
Bonemeal.....	10	Bonemeal.....	10
Salt.....	15	Salt.....	15
No. 15		No. 16	
Ground corn.....	300	Ground corn.....	400
Ground oats.....	225	Ground oats.....	325
Wheat bran.....	150	Soybean oilmeal or mixture of soybean oilmeal and cotton- seed meal.....	250
Ground soybeans or mixture of ground soybeans and linseed meal.....	300	Bonemeal.....	10
Bonemeal.....	10	Salt.....	15
Salt.....	15		
No. 17		No. 18	
Ground corn.....	475	Ground corn.....	375
Wheat bran.....	250	Ground oats.....	250
Soybean oilmeal or mixture of soybean oilmeal and cotton- seed meal.....	250	Soybean oilmeal or mixture of soybean oilmeal and cotton- seed meal.....	100
Bonemeal.....	10	Ground soybeans or mixture of ground soybeans and linseed meal.....	150
Salt.....	15	Corn gluten feed or brewers' dried grains.....	100
		Bonemeal.....	10
		Salt.....	15

Feed Substitutions in Formulas

Note: In addition to the substitutions indicated in the foregoing formulas, ground barley or ground wheat may be substituted pound for pound for ground oats or ground corn. The ground corn may be either shelled corn meal or corn-and-cob meal. The use of two or more farm grains in each mixture is recommended. Ground soybeans are not recommended if soybean hay is fed, unless the hay is cut before the seed is well developed.

The above formulas and substitutions are adapted from Cir. 502, Ill. Agr. Exp. Sta.

When ready-mixed protein supplements or complete, ready-mixed feeds are purchased, they may be combined with farm grains to form mixtures containing the proper amounts of protein for use with different classes of roughage. The required amounts of each are given in Table XXI. As already

TABLE XXI

AMOUNTS OF READY-MIXED FEEDS AND FARM GRAINS REQUIRED TO MAKE MIXTURES CONTAINING SPECIFIED AMOUNTS OF TOTAL PROTEIN

Kind of Feed	Pounds of Feeds to be Mixed to Give a Total Protein Content of		
	13 Per Cent	15 Per Cent	18 Per Cent
32 per cent mixed feed.....	100	100	100
Farm grains.....	800	300	200
24 per cent mixed feed.....	100	100	100
Farm grains.....	400	200	75
20 per cent mixed feed.....	100	100	100
Farm grains.....	300	100	25
16 per cent mixed feed.....	100	100	*
Farm grains.....	75	25	

* Not sufficiently high in protein.

pointed out, a good job of feeding requires that the grain mixture properly supplement the kind of roughage fed. It is not always possible or economical to purchase a ready-mixed feed containing the proper amount of protein to suit certain conditions. Therefore, study the formulas given in this section, as well as the figures given in Table XXI, so that you will be prepared to make up a formula for a suitable grain mixture from any feeds that may be available on the market. It should be mentioned, however, that occasionally protein

supplements are cheaper than farm grains and under such conditions the feeding of more protein than is needed may be justified.

6. GRINDING AND MIXING GRAINS AND SUPPLEMENTS

Grinding grains for high-producing dairy cows is an economical and desirable practice, especially when prices of feed and milk are high. The grinding of farm grains increases their digestibility 10 to 20 per cent. The feeding of grain in ground



FIG. 51. A FIELD OF ALSIKE CLOVER IN FULL BLOOM

Alsike clover hay is an excellent roughage for winter feeding. It is finer stemmed, more palatable, and slightly higher in protein than red clover hay. Alsike clover is also useful in pasture mixtures.

form enables high-producing cows to maintain high milk yields because they are able to obtain the required amount of digestible nutrients from a smaller quantity of feed than if the grains were fed whole. For low-producing and dry cows, the cost of grinding should be compared with the increase in nutritive value brought about by grinding.

Grind grains for dairy cows to a medium degree of fineness. Very fine grinding seems to cause little increase in digestibility and may decrease palatability; it is likely to increase the cost because more power is required. The protein supplements used in mixtures for dairy cows are best purchased in the

meal or ground form, rather than in the cake or nut form, in order to provide for more thorough mixing with the ground grains.

Mix the ingredients of the concentrate mixture thoroughly. Unless this is done, the proper amounts of each of the constituents can not be fed. When the grinding of farm grains is done at a commercial mill, the load of grain may be weighed and the proper amounts of protein supplements spread over the top of the load. The load of feed is then shoveled into the hopper of the grinder and the grain and supplements are ground and mixed in one operation.

Batches of home-ground grain are most simply mixed by thorough shoveling in long, low piles not more than 2 or 2½ feet deep. Add the protein supplements and 1½ pounds of salt for each 100 pounds of concentrates.

Newly harvested corn usually contains so high a percentage of moisture that in warm weather, or because of storage in a warm place, it soon becomes rancid after grinding. In using high-moisture corn in grain mixtures, grind only enough for one or two weeks' feeding.

7. FEEDING THE GRAIN MIXTURE

Directions have been given for formulating a suitable grain mixture, for grinding farm grains, and for mixing ground grains and protein concentrates. On many farms, however, the grain mixture fed consists of ready ground-and-mixed feed purchased on the market. Whichever sort is used, a few simple principles in the feeding of the grain mixture must be followed if the best results are to be obtained.

Procedure:

- A. Determine and record milk yields.
- B. Feed in proportion to milk production.

A. Determine and record milk yields. Weigh the milk produced by each cow during at least one day each week, and

record the amount on a simple feeding chart. The chart should be checked each week and any considerable changes in yields noted.

B. Feed in proportion to milk production. Good roughage liberally fed supplies enough nutrients for maintenance of the cow's body and usually for moderate milk yields as well. For high milk yields, grain mixture is needed in addition to the roughage.

Investigations show that after the body maintenance needs are met, the amount of nutrients required for milk production is in exact proportion to the amount of milk produced. In other words, the amount of nutrients required for the production of 10 pounds of milk daily, let us say, is 10 units; for 20 pounds of milk, it is twice as much, or 20 units, and so on. Hence, feed the grain mixture in proportion to the milk yield.

When high-quality roughage is fed, more is consumed than when the roughage is of poor quality, and the grain mixture is then fed at a lower rate. The breed of cow also influences the rate of feeding. Guernsey and Jersey milk contains more fat and more solids than are not fat than the milk of the other dairy-cattle breeds, and hence more nutrients are required for the production of each pound of it.

Rates of feeding grain mixture under winter-feeding conditions are given in Table XXII. With the aid of this table and the chart showing milk yields, complete the chart which is to serve as the guide to daily feeding. Attach the chart to your feed cart or grain bin from which grain mixture for each cow is weighed out, and follow it at each feeding time.

Study each cow individually. Some cows eat less roughage than others and thus require more grain mixture. If a cow is being fed too little to enable her to produce at her best, this will usually not be discovered until she is fed a little more than seems to be actually required so that she has opportunity to increase her production.

It can not be emphasized too strongly that weighing the grain mixture for each cow is one of the most important of

TABLE XXII

SUGGESTED RATES OF FEEDING GRAIN MIXTURE TO COWS DURING THE WINTER SEASON*

Mixture Fed and Breed of Cattle	Amounts of Grain Mixture to be Fed Daily	
	When roughage is fed liberally (all that the cows will eat without undue waste)	When roughage is fed in moderate amounts
<i>Low in Protein</i>		
About 13 per cent protein; Mixtures Nos. 1-6		
Ayrshire, Holstein, Swiss..	1 lb. grain mixture to 3.5 lb. milk	1 lb. grain mixture to 3 lb. milk
Guernsey, Jersey.....	1 lb. grain mixture to 3 lb. milk	1 lb. grain mixture to 2.5 lb. milk
<i>Medium in Protein</i>		
About 15 per cent protein; Mixtures Nos. 7-12		
Ayrshire, Holstein, Swiss..	1 lb. grain mixture to 4 lb. milk	1 lb. grain mixture to 3.5 lb. milk
Guernsey, Jersey.....	1 lb. grain mixture to 3.5 lb. milk	1 lb. grain mixture to 3 lb. milk
<i>High in Protein</i>		
About 18 per cent protein; Mixtures Nos. 13-18		
Ayrshire, Holstein, Swiss..	1 lb. grain mixture to 4 lb. milk	1 lb. grain mixture to 3.5 lb. milk
Guernsey, Jersey.....	1 lb. grain mixture to 3.5 lb. milk	1 lb. grain mixture to 3 lb. milk

* Adapted from Cir. 502, Ill. Agr. Exp. Sta.

all operations in connection with the management of a dairy herd; however, if it is not possible to weigh the grain mixture, it may be fed in approximately correct amounts by measuring in a 4- or 6-quart measure, or a pail with vertical sides which has been marked to indicated single quarts.

8. PROVIDING AN AMPLE QUANTITY OF MINERALS

Knowledge of the exact requirements of dairy cattle for minerals is still incomplete. Investigations of mineral needs are complicated by the close association of the mineral elements and the vitamins in nutrition. For example, calcium assimilation in the growing animal requires the presence of vitamin D. Until further and more definite information is available, nothing more than general recommendations can be made.

Procedure:

- A. Study mineral content of ration.
- B. Provide high-mineral feeds and needed supplements.

A. Study mineral content of ration. Dairy cattle, like other ruminants, require large amounts of sodium and chlorine, the elements of common salt. These elements are constantly required and supplying salt only one or two days a week is not satisfactory for high-producing cows. Ascertain whether or not the grain mixture you are feeding contains salt, the percentage present, and whether the cows are receiving all they care for.

Turn to Table XXIII and to Plate 6 and determine whether the ration fed is relatively high or low in calcium (lime) and phosphorus content. It will be noticed that certain classes of feeds, such as the legume hays, are very high in calcium; whereas other classes, such as the cereal grains, are very low. On the other hand, protein supplements, such as wheat bran

and cottonseed meal, contain large amounts of phosphorus; and most of the roughages furnish but small amounts.

The lime content of roughages grown on acid soils and on those low in fertility is likely to be low. Phosphorus may be deficient in rations which consist largely of roughages, since

TABLE XXIII
MINERAL CONTENT OF FEEDS *

Feed	Dry Matter, Per Cent	Total Ash, Per Cent	Potas- sium, Per Cent	Calcium, Per Cent	Mag- nesium, Per Cent	Phos- phorus, Per Cent
Alfalfa hay.....	92.58	6.38	0.770	1.046	0.370	0.221
Beans, navy.....	85.51	3.78	1.186	0.201	0.176	0.367
Beet pulp, dried....	90.47	2.91	0.314	0.660	0.256	0.062
Bluegrass hay.....	91.71	4.82	1.290	0.308	0.220	0.222
Clover hay.....	92.43	6.76	1.701	1.142	0.270	0.169
Corn.....	85.76	1.21	0.340	0.012	0.108	0.260
Corn gluten feed....	92.01	3.18	0.250	0.247	0.220	0.542
Corn stover.....	93.04	6.52	1.718	0.472	0.086	0.095
Cottonseed meal....	91.42	6.98	1.656	0.266	0.548	1.352
Cowpeas.....	85.76	3.69	1.403	0.100	0.208	0.456
Cowpea hay.....	89.38	10.76	0.780	1.814	0.980	0.253
Kafir corn, grain....	88.11	1.18	0.254	0.012	0.125	0.239
Linseed oil meal....	89.66	5.80	1.098	0.362	0.488	0.705
Mangel wurzel.....	11.46	1.18	0.444	0.015	0.041	0.030
Milk, skim.....	9.59	0.69	0.122	0.128	0.014	0.094
Millet hay.....	95.11	5.60	1.273	0.310	0.249	0.165
Oats.....	91.11	3.38	0.419	0.102	0.118	0.395
Soybeans.....	91.37	5.06	1.913	0.210	0.223	0.592
Soybean hay.....	89.39	7.67	1.586	1.232	0.619	0.212
Timothy hay.....	91.94	3.20	0.564	0.177	0.102	0.113
Wheat.....	87.69	1.64	0.520	0.050	0.130	0.373
Wheat bran.....	89.98	6.06	1.320	0.125	0.531	1.110
Wheat middlings....	88.98	4.12	1.021	0.096	0.383	0.876
Whey.....	6.04	0.56	0.167	0.044	0.008	0.039

* Ohio Agr. Exp. Sta., Bul. 255.

most roughages contain relatively small amounts of this element. Dairy cattle fed entirely on roughages, including pastures, which are grown on soils deficient in phosphorus may suffer from serious disturbances, including slow rate of growth, lessened milk production, impaired reproduction, and breakdowns in health.

The drinking water and feeds of certain areas, notably some sections near the Great Lakes and in Montana, supply too

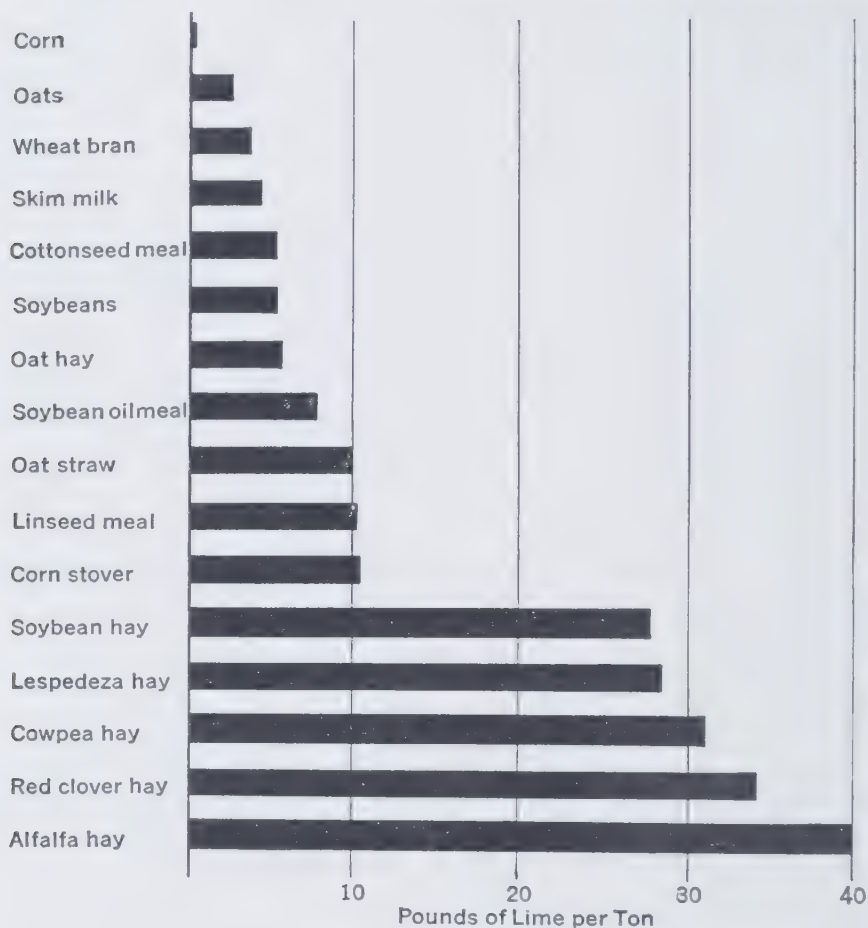


PLATE 6. AMOUNTS OF LIME IN SOME COMMON FEEDS

Note the large amounts of lime in the legume hays and the small amounts in corn and oats. Skim milk, a liquid, furnishes more lime than some of the dry feeds. This chart shows that legume hays and skim milk are unsurpassed by other feeds as sources of lime for dairy cattle.

small amounts of iodine. A few areas have been found in which roughage is low in copper and iron content.

As already indicated, tables of the mineral composition of feeds are valuable aids in the general evaluation of a ration

with respect to its calcium and phosphorus content. Such tables, as well as mineral analyses of particular rations, are seldom sufficient guides to the mineral adequacy of a ration. Much depends upon the amount of feed consumed, the production of the animal, and the vitamin content of the ration. Even when a presumably adequate ration is supplied, the herdsman must be constantly watchful for symptoms of mineral deficiency in his animals.

B. Provide high-mineral feeds and needed supplements.

Provide dairy cows with free access to salt. The crystal form of salt is preferable to rock salt for dairy cows, especially during cold weather. If not possible to allow free access to salt, include salt in the grain mixture at the rate of 1.5 to 2 pounds in 100 pounds of the mixture.

Present knowledge indicates that the needs of dairy cows for lime are best supplied by legume roughages. When liberal amounts of well-cured or well-preserved legume roughages can not be supplied in liberal amounts, supply ground limestone or bonemeal of feeding grade.

Phosphorus is best supplied through the use of well-balanced concentrate mixtures containing feeds especially rich in phosphorus, such as cottonseed meal, wheat bran, linseed meal, soybean meal, and gluten feed. When but small amounts of these protein supplements are being consumed and when grass pastures on low-phosphorous land furnish the principal part of the ration, supply a simple phosphorus supplement such as steamed bonemeal.

Rations low in both lime and phosphorus may be efficiently supplemented by keeping a mixture of equal parts of ground limestone, steamed bonemeal, and salt in a container to which the cattle have ready access. If this arrangement is not feasible, as in winter, incorporate these substances in the grain mixture at the rate of 1 pound of limestone, 1 pound of bonemeal, and 1.5 to 2 pounds of salt in every 100 pounds of grain mixture. The application of ground limestone and phosphorus fertilizer to soils deficient in these minerals is an

effective means of increasing the lime and phosphorus content of the forages grown thereon.

The presence of goiter in the calf at birth or soon after birth is evidence of deficiency of iodine in the feed and water. If this trouble is encountered, supply iodized salt instead of ordinary salt to the cows during the last two or three months of pregnancy. Because milk from cows fed iodine varies greatly in its concentration of this element, the practice of



FIG. 52. CORN STOVER HAS ONLY FAIR FEEDING VALUE FOR DAIRY COWS

Corn stover is much lower than legume hays in protein, lime, and phosphorus. When corn stover is bleached by exposure to the weather, the vitamin content becomes low. Further, a high proportion of the dry stover is refused by dairy cows. Ensiling the corn crop aids in the preservation of the vitamins and reduces the amounts of refused feed to nearly nothing.

producing special "iodized milk" for the market in this manner can not be recommended unless the product is given careful laboratory tests regularly.

Anemia, or "salt sick," of cattle has been recognized in only a few areas, one of these being a section of Florida where soils and the forages grown thereon are especially deficient in mineral content. The Florida Agricultural Experiment Station² recommends a mixture of 100 pounds of

² Bul. 231, Fla. Agr. Exp. Sta.

salt, 25 pounds of red oxide of iron, and 1 pound of finely ground copper sulphate as suitable for correcting such deficiencies, the mixture being placed where the cattle have free access to it.

A deficiency of cobalt in the forage has been found in a few areas, including parts of New Zealand and Australia. This condition may be corrected by the addition of as little as one-fourth pound of cobalt salts to the acre. This is an illustration of the extremely small amounts of some of the mineral elements that are needed in nutrition.

A number of mineral elements in addition to those mentioned here are needed in animal nutrition, some of them being required in minute quantities. Future investigations may bring to light improvements in the feeding of dairy cows through the addition of some of these elements to the ration or to the soil on which feed crops are grown.

The feeding of complex mineral mixtures or complex mixtures of minerals and vitamins usually is not good feeding practice because it is seldom that all the ingredients of such mixtures are needed, and if one or more are needed, the quantities of the particular substances fed are likely to be insufficient. Then, too, the continued feeding of unneeded compounds may in time prove harmful.

9. INSURING AN ADEQUATE VITAMIN INTAKE

It is known that dairy cows require several vitamins, but the extent to which vitamins must be supplied and the best manner in which to do this have not yet been fully determined. Enough information is available, however, so that general recommendations can be made.

Procedure:

- A. Study vitamin content of ration.
- B. Supply some vitamin-rich feeds.

A. Study vitamin content of ration. Read the discussion of vitamins in Section 1 of General Information which follows, and study Tables XXIV and XXV. Make a list of the feeds contained in your ration and grade each feed as high or low in vitamin content. Rate the ration as a good or a poor source of vitamins, giving particular attention to the vitamins known to be most needed.

B. Supply some vitamin-rich feeds. If you have rated your ration as poor in vitamin content, improve the ration if possible by the inclusion of some vitamin-rich feeds. During the growing season this is most readily accomplished by giving the animals access to fresh, green pasture or by the use of soiling crops. Summer sunlight is beneficial in providing vitamin D. In the winter season dependence must be placed on green, leafy, sun-cured roughages and other vitamin-rich feeds listed in Tables XXIV and XXV.

There is often a question whether one should or should not attempt to carry his herd through the winter on home-raised roughages that are of poor quality. Frequently, a vitamin-deficient ration is fed during the last few weeks of the winter season because the supply of good hay has been exhausted and pasture will soon be available. This practice is not desirable but may not prove very harmful. On the other hand, the use of a low-vitamin ration throughout the entire winter may have exceedingly disastrous effects on reproduction and also may lower milk yields.

GENERAL INFORMATION

1. THE COMPOSITION OF FEEDS

Feeds may be grouped roughly into two classes, based upon composition and appearance, as follows: (1) **Concentrates**, such as farm grains and mill by-products. Most of these are heavy in proportion to bulk and contain a small amount of fiber, or cellulose. As a rule, they are high in digestible nutrient

TABLE XXIV
SIMPLE CLASSIFICATION OF FEEDS *

Palatable Feeds

<i>Roughages</i>		<i>Concentrates</i>
Corn silage	Barley	Molasses
Fresh green roughages	Beet pulp	Oats
Legume hays, when in good condition	Corn	Wheat
Roots and tubers, pumpkins, etc.	Hominy feed	Wheat bran
	Linseed meal	Wheat middlings

Laxative Feeds

<i>Roughages</i>		<i>Concentrates</i>
Corn silage	Flaxseed meal	Soybeans
Fresh green roughages	Linseed meal	Soybean oil meal
Legume hays	Molasses	Wheat bran
Roots and tubers		

Constipating Feeds

<i>Roughages</i>		<i>Concentrates</i>
All hays except the legumes	Corn	Cottonseed meal
Corn stover		
Straw from the cereal grains		

Bulky Feeds

<i>Roughages</i>		<i>Concentrates</i>
All roughages	Alfalfa meal	Hulls of various seeds
	Beet pulp	Oats, ground
	Buckwheat bran	Rye bran
	Corn bran	Wheat bran

High-protein Feeds

<i>Roughages</i>		<i>Concentrates</i>
	Coconut meal	Linseed meal
	Corn gluten feed	Peanut meal
	Corn gluten meal	Peas and beans
	Cottonseed meal	Soybeans
	Flaxseed meal	Soybean oil meal

Medium-protein Feeds

<i>Roughages</i>	<i>Concentrates</i>
All legume hays (as compared with non-legume roughages)	Cowpea seed
	Wheat bran
	Wheat middlings

TABLE XXIV—*Continued*

Low-protein Feeds		
<i>Roughages</i>		<i>Concentrates</i>
Nearly all non-legume roughages	Barley	Molasses
	Beet pulp	Oats
	Corn	Rye
	Corn-and-cob meal	Wheat
	Hominy feed	
High-vitamin Feeds		
<i>Roughages</i>		<i>Concentrates</i>
Carrots, yellow		Cod-liver oil and other fish oils
Green, growing crops, including pasture		Wheat germ
Hay, green, leafy, especially legume hay		Yeast, dried
Medium-vitamin Feeds		
<i>Roughages</i>		<i>Concentrates</i>
Hay from grasses, high quality		Cereal grains
Milk and milk products		Protein concentrates, except fish meal,
Silage having green color		meat scraps, and tankage
Low-vitamin Feeds		
<i>Roughages</i>		<i>Concentrates</i>
Corn fodder and stover		Beet pulp, dried
Hays, bleached and low in leaf content		Fish meal
Straws from cereal grains		Meat scraps
		Molasses, cane
		Tankage

* Adapted from Ill. Agr. Exp. Sta., Circ. 272.

Note: See also Table XXVI.

value. (2) **Roughages**, feeds bulky in proportion to weight, such as hay, straw, grass, silage, and roots. Most of these feeds contain large amounts of fiber, and are lower than the concentrates in digestible nutrient value. Some roughages, such as silage, fresh green grass, and roots, are high in water content and therefore are termed **succulent feeds**.

There are seven classes of substances in most feeds: protein, carbohydrates, fats or oils, mineral matter or ash, vitamins, pigments, and water.

TABLE XXV

APPROXIMATE AMOUNTS OF VITAMINS IN FEEDS AND DAIRY PRODUCTS *

Feed or Dairy Product	Vitamin				
	A	B	C	D	G
Alfalfa leaf meal, dried.....	12,000	—	—	—	—
Barley.....	0	110	0	—	—
Beet (mangels).....	—	—	3.5	—	—
Butter					
Average.....	2,200	—	—	80	—
Cows on dry feed.....	1,200	—	—	40	—
Cows on pasture.....	3,500	—	—	150	—
Carrot					
Young.....	3,000	50	7	—	50
Mature.....	5,500	50	7	—	50
Cheese					
Cheddar.....	2,500	—	—	—	200
Cottage.....	80	—	—	—	—
Cream.....	3,500	—	—	—	45
Cod-liver oil.....	50,000 to 200,000	—	—	10,000 to 50,000	—
Corn					
White, dried.....	0	130	—	—	—
Yellow, dried.....	600	130	—	—	—
Cottonseed meal.....	0	470	—	—	170
Cowpea, dried.....	250	—	—	—	140
Hominy					
White.....	0	—	—	—	—
Yellow.....	830	—	—	—	—
Kafir grain.....	40	—	—	—	—
Milk, whole					
Average market.....	165	20	0	2	60
Cows on dry feed.....	80	20	1	1	30
Cows on pasture.....	250	20	3	4	90
Colostrum.....	5 to 15 times usual amount	—	—	—	—
Skim.....	2	—	—	—	—
Dried.....	20	180	—	—	625
Molasses.....	—	0	—	—	—
Oats.....	0	135	0	—	—
Potato.....	40	40	15	—	25
Pumpkin.....	—	—	10	—	—
Soybean, dried, yellow.....	—	500	—	—	900
Turnip.....	—	30	40	—	20
White.....	0	—	—	—	—
Yellow.....	16	—	—	—	—
Wheat.....	15	150	0	—	80
Bran.....	—	200	—	—	—
Germ.....	—	1200	—	—	300
Middlings.....	5 to 30	600	—	—	—
Yeast, brewers', dried.....	—	260	—	—	885

* Expressed in units per 100 grams. (Vitamins A, B, C, and G in Sherman units, vitamin D in International units.) A dash indicates that no determination was made; a zero shows that none was found in the samples tested. From Vitamin Content of Foods, Misc. Pub. 275, June, 1937, U. S. Dept. of Agr.

Protein is the only one of the principal constituents that contains nitrogen. Protein is very essential, for it is necessary in growth and in the repair of the tissues, as a constituent of milk, and in the development of the fetus. Without protein, these processes could not take place. Protein is usually the most costly substance in the ration, for feeds rich in this constituent are relatively scarce.

Proteins are complex chemical compounds which are broken



FIG. 53. SORGHUM FODDER IS A POOR FEED FOR DAIRY COWS

Dry sorghum fodder is usually unpalatable to dairy cows, and in addition has many of the objectionable features of corn stover. Sorghum fodder retains the plant juices tenaciously and, unless care is taken in curing, may mold. Ensiled at the proper stage, sorghum makes good silage, especially if mixed with corn as it is being ensiled.

down in the digestive processes of the animal to much simpler chemical units called amino acids. Even the amino acids, however, have a considerable degree of complexity. About twenty-two different amino acids have been chemically identified and there may be still others not yet recognized.

The amino acids are absorbed from the intestinal tract into the blood stream and are recombined into proteins of the muscles, nerves, hair, horns, milk, etc. These proteins contain exactly the same amino acids as the proteins of the feeds

consumed but have entirely different characteristics from the feed proteins simply on account of the different assortment and proportions of amino acids they contain. Milk protein contains all the amino acids necessary for maintenance and rapid growth of young animals, and these amino acids are

Corn Alone Does Not Support Growth

An Eight Week Feeding Trial Showing the Effects of Mineral
and Protein Supplements

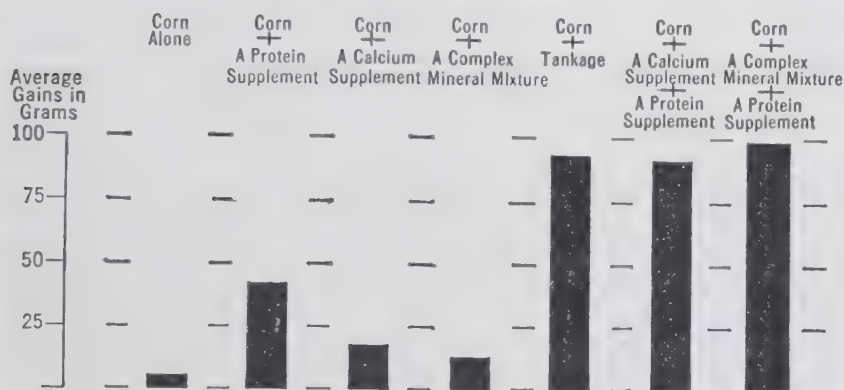


PLATE 7. CORN ALONE IS AN UNSATISFACTORY RATION

In this experiment with groups of white rats, the supplements used were as follows: The "protein" supplement was casein, the chief protein of milk; the "calcium" supplement, calcium carbonate; the "complex mineral mixture," a laboratory preparation of pure mineral compounds furnishing potassium, phosphorus, calcium, magnesium, iron, manganese, aluminum, sulphur, fluorine, iodine, zinc, and cobalt; the "tankage" was a commercial slaughterhouse by-product furnishing both protein and minerals. Common salt was supplied to all groups.

The results of this experiment indicate that corn is nutritionally deficient in calcium and in the quality of its protein. It is likely that the slight differences in the gains shown by the three columns at the right are insignificant and that the three rations giving the largest gains were of about equal value. Thus the importance of providing for adequate quality of protein and mineral matter in the ration is emphasized.

also in such good proportions that the protein is efficiently utilized. For this reason, milk proteins are called complete proteins. On the other hand, some proteins are incomplete as demonstrated by feeding experiments in which animals, fed rations containing only one particular protein, can not grow or even maintain constant live weight. An example of an incomplete protein of this kind is gelatin.

Farm feeds, as a rule, contain a fairly good assortment of amino acids, and when rations are made from good-quality roughages and simple grain mixtures like those given in Section 5 of this chapter, there is not likely to be a deficiency in the quality of the protein. It is doubtful if there is any advantage from the standpoint of efficiency of utilization of protein in the use of grain mixtures containing a large number of ingredients.

Carbohydrates consist of two groups of substances, the nitrogen-free extract and the fiber. The nitrogen-free extract comprises the starches and sugars of the feed. It is not determined by chemical means, but by difference. The total weight of the sample of feed less the sum of the protein, fat, mineral matter, fiber, and water, is assumed to be the weight of the nitrogen-free extract. The fiber is the least digestible part of feeds, and for this reason feeds very high in fiber, such as corncobs and cottonseed hulls, have a relatively low feeding value.

The **fats** and **oils** of feeds include the true fats and oils which serve much the same purposes in the body as the carbohydrates. Because the chemist includes under the term fats and oils all the compounds that are extracted from feeds by warm ether, including the true fats and oils, the coloring matter (pigments), waxes, resins, etc., this group of substances is frequently called ether extract. The waxes, resins, and pigments form but a small percentage of the total and are in the main indigestible. Improved methods of extracting oils from seeds have resulted in the production of oil meals very low in their content of oil. Recent investigations by the New York (Cornell) Agricultural Experiment Station³ indicate that the fat content of the grain mixture fed to milking cows should be not less than 4 per cent.

Mineral matter, or **ash**, ranks with the vitamins in the number of important body functions which it fulfills. The quantity in feeds is much greater than that of the vitamins,

³ Buls. 543, 593, 722, Cornell Agr. Exp. Sta.

however, the amounts in roughages ranging roughly from 4 to 9 per cent and in concentrates from 1.5 to 4 per cent. The chemist determines the mineral matter in a feed by burning a weighed sample. The residue comprises the mineral matter, or ash.

Vitamins are present in feeds in extremely small amounts, but they may be considered the most important of all constituents of a ration.

In the past the kinds and relative amounts of vitamins in



FIG. 54. CULTIVATING PEANUTS ON A VIRGINIA FARM

The weeds in the rows are first removed by hand hoeing and the mule-drawn cultivator follows to complete the job. A by-product of this crop, peanut oilmeal, finds an important place in the feeding of dairy cattle.

feeds were determined by conducting feeding experiments with laboratory animals. The chemical composition of the vitamins was unknown until recent years. Advances in vitamin research have made it possible to learn the chemical identity of a number of the vitamins and have also provided means for the quantitative determination of some of them. These methods are as yet too time-consuming and expensive to be used in routine feed analysis and for this reason commercial analyses of feeds include only the moisture, protein, carbohydrates, ether extract, and ash.

Vitamin A is one of the most important vitamins for dairy cattle. It promotes growth, protects the eyes and mucous membranes, and is important in the reproductive functions of both males and females.

The term **vitamin B** is now little used. Formerly it meant the substance which protects the nerves and prevents beri-beri in man. This compound, now known as thiamin, also helps to keep the appetite, muscles, and digestive tract in good order. In addition to thiamin, a number of other compounds having important functions were once included under the term vitamin B. Special provision for supplying these substances to dairy cattle need not be made because good-quality grains and roughages contain liberal amounts of vitamin B, and also because bacteria living on the roughage in the rumen synthesize considerable quantities.⁴

Vitamin C prevents scurvy in man, but evidence that dairy cattle require it in the ration is still lacking. It is assumed that cattle are able to synthesize this vitamin in quantities sufficient for their needs.

Vitamin D is necessary for the assimilation of calcium and phosphorus. It ranks with vitamin A in its importance for dairy cattle. It is needed by cattle during all phases of growth, and it is assumed that it is also needed during pregnancy, during lactation to assist in the mobilization of calcium and phosphorus for the milk, and during adult life to prevent the withdrawal of excessive amounts of calcium and phosphorus from the skeleton (osteomalacia). Most feeds contain small amounts of ergosterol, a compound which is converted to vitamin D by action of sunlight. The amounts of vitamin D in hays and other feeds is increased by exposing them to sunlight. Ergosterol is also present in the skin and is converted to vitamin D by exposure of the skin to direct rays of the sun or to ultra-violet rays from specially constructed lamps. In winter the potency of the sun's rays is so low that calves and cows

⁴ Jour. Biol. Chem., LXXX, 231, 1928.

need to be supplied with roughages that have been sun cured.

Vitamin E is needed by some species of animals for reproduction. If dairy cattle require this vitamin, ample supplies are provided in well-balanced rations because the vitamin is found in both concentrates and roughages.

Vitamin G comprises a group of substances, including riboflavin and nicotinic acid. It is assumed that dairy cows are able to synthesize large amounts of these compounds and to secrete them in the milk even when the ration provides limited



FIG. 55. LESPEDEZA AIDS IN RAPID SOIL IMPROVEMENT

Korean lespedeza is a legume crop which is effecting improvement in cropping systems and in soil improvement in Missouri, southern Illinois, Kentucky, Tennessee, and other southern states. As shown in this picture taken in August in southwestern Indiana, it makes a dense growth of short, leafy plants. The soil of this field consisted of poor, untreated clay, but the yield of hay harvested during the latter part of August was more than a ton to the acre. Like other legumes, however, lespedeza responds well to soil treatment.

quantities. Milk is a good source of both riboflavin and nicotinic acid for man. A deficiency of nicotinic acid in man's diet subjects him to a skin disease known as pellagra.

A number of other vitamins have been described by scientists, but their requirements in the rations of cattle are unknown. It is assumed that ample amounts are supplied under conditions of good feeding practice, and that in dairy-cattle feeding attention need be given only to supplying ample amounts of vitamins A and D.

180 FEEDING THE DAIRY COW DURING WINTER SEASON

TABLE XXVI *

NUTRIENTS IN 100 POUNDS OF VARIOUS DAIRY FEEDS

Feed	Total Dry Matter, Pounds	Total Protein, Pounds	Digestible Protein, Pounds	Total Digestible Nutrients, Pounds
Concentrates				
Barley	90	11	9	79
Beet pulp, dried	90	9	5	70
Brewers' dried grains	90	25	20	64
Coconut meal or cake, old process	90	21	19	79
Corn, shelled, grade No. 3	85	9	7	80
Corn-and-cob meal	85	8	6	64
Corn gluten feed	90	23	20	77
Corn gluten meal	90	40	34	80
Cottonseed meal, 43% protein	90	43	34	74
Cottonseed meal, 41% protein	90	41	33	72
Cowpea seed	90	24	20	78
Distillers' dried grains (from corn)	90	30	21	82
Hominy feed	90	10	7	85
Linseed meal, 37% protein	90	37	32	76
Linseed meal, 34% protein	90	34	30	77
Molasses, cane, or blackstrap	75	3	1	57
Oats	90	12	9	70
Peanut oilmeal, high grade	90	41	36	79
Rye	90	12	10	80
Soybean oilmeal	90	41	37	81
Soybean seed	90	37	33	86
Wheat	90	12	9	80
Wheat bran	90	15	13	70
Wheat middlings, standard	90	17	14	78
Milk				
Whole milk (cow's)	13	4	4	16
Skimmilk	10	4	4	9
Skimmilk, dried	95	35	33	84
Roughages				
Alfalfa hay	90	15	10	50
Alfalfa leaves	90	21	16	58
Alfalfa silage	28	5	3	15
Bluegrass hay	90	8	5	54
Clover, alsike, hay	90	12	8	49
Clover, red, hay	90	12	7	53
Clover, sweet, hay	90	14	6	30
Corn fodder, dry (with ears)	90	7	3	44
Corn fodder, green (with ears)	23	2	1	16
Corn silage	30	2	1	20
Corn stover, dry (without ears)	90	6	2	38
Cowpea hay	90	19	11	41
Cowpea straw	90	7	2	26
Lespedeza hay	90	13	9	52
Lespedeza straw	90	7	4	40
Oat hay	90	8	5	47
Redtop hay	90	7	4	53
Sorgo silage	25	2	1	15
Soybean hay	90	14	9	42
Soybean silage	30	4	2	16
Soybean straw	90	4	0	24
Timothy hay	90	6	3	48
Roots, etc.				
Beet, common	13	2	1	10
Mangel	9	1	1	7
Pumpkin, field	10	2	1	9

* From Cir. 502, Ill. Agr. Exp. Sta.

The **pigments** of feeds are the substances which give color to them. They are found in all forages. One of the most important pigments for dairy cattle is carotene, the yellow pigment found in carrots, yellow pumpkins, and also in nearly all green plants. The carotene in green plants is masked by the green chlorophyll, but the two are easily separated in the chemical laboratory.

Plants contain very little if any vitamin A but cattle convert a part of the carotene to vitamin A. The natural yellow color of butterfat is largely carotene. Milk produced from fresh, green pasture has a high yellow color, and the body fat, ears, and tails of some of the dairy breeds show much yellow color. The source of this color is the carotene of the feed.

Water is present in all feeds. Silage, roots, and fresh grass contain 65 to 90 per cent of water, and even the farm grains when cured for storage contain 9 to 12 per cent.

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- Bean; 1520, Soybeans; 1539, High-grade Alfalfa Hay; 1597, Johnson Grass for Hay and Pasture; 1602, Reed Canary Grass; 1605, Soybean Hay and Seed; 1617, Soybean Utilization; 1626, Feeding Dairy Cows; 1653, Sweet Clover in the Corn Belt; 1699, Growing Root Crops for Livestock; 1722, Growing Alfalfa; 1723, Feeding, Care, and Management of Young Dairy Stock; 1724, Lespedeza; 1844, Use of Sorghums for Forage.
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COMMUNITY STUDIES

During the winter feeding season, visit several dairy farmers who are willing to tell you how they feed their cows. By asking questions, and also by observing, obtain as much as possible of the information suggested by the following:

1. Note the kind and quality of the roughages fed at each of the farms. List the ingredients of the grain mixtures fed. Do all the rations fulfill the qualities of an ideal ration? In what respects are the rations deficient? What improvements do you suggest?
2. Are the roughages home-grown or purchased? What improvements might be made in the cropping system to provide better-quality roughages for the dairy herd? Could changes be made in the methods of harvesting or storing that would result in better-quality roughage?
3. How many times daily is hay fed? Silage? Amounts of hay and silage per cow?
4. Are the roughages consumed liberally? What changes might be instituted to bring about a greater consumption of roughage?
5. How often is refuse removed from the mangers? What disposition is made of the coarse stems, if any, remaining?
6. Are the mangers kept in a clean and sanitary condition?

7. Is the grain mixture home-mixed? Formula used? In your opinion is this suitable for the kind and quality of roughage fed?
8. If grain mixture is home-mixed, what kind of an outfit is used for grinding? How is feed mixed? Can you suggest improved methods?
9. If grain mixture is purchased ready-mixed, what is the total protein content? Is this protein content correct for the kind and quality of roughage fed? If not, how could this be remedied?
10. Is the grain mixture fed in proportion to milk yields? Rate of feeding?
11. How often is the milk of each cow weighed? Kind of record kept? How often is the rate of grain-mixture feeding changed to correspond to changes in milk yields? Possible improvements here?
12. Is salt included in the grain mixture? Amount? If not included in the grain mixture, how is it supplied? Do the cows receive an adequate supply?
13. Are mineral supplements other than salt used? Kind, amount, and manner of feeding? Why are these supplements used; that is, are they added merely as a precautionary measure, or is the roughage low in minerals?
14. Are efforts made to keep the vitamin content of the ration high? If so, what methods are used? Are these methods effective in maintaining a high carotene content in the milk?
15. Are vitamin supplements fed? Kind and amount? Reason for use?
16. Compare the information obtained from your visits to these farms with the recommendations given in this chapter. Make a list of the commendable practices found on each farm and also your detailed suggestions for improvement in the feeding methods used.

CHAPTER IX

FEEDING THE DAIRY COW DURING THE PASTURE SEASON

Many dairy farmers believe that when cows are turned to pasture in the spring much responsibility as well as labor has been removed, and that from then on for a period of five or six months the cows can care for themselves so far as obtaining a supply of feed is concerned. This is often a serious mistake, for even though the pasture grass is tall and succulent, it may be so high in water content that the cows can not consume enough of it to supply their needs. Then, too, the decline in milk flow, which usually occurs when flies become numerous and is generally attributed to the annoyance of flies, is most often caused by the failure of the pasture to furnish sufficient feed.

Good pastures are usually the most economical sources of feed for dairy cattle, and for this reason the summer feeding of dairy cattle is deserving of much more attention than usually is given it.

Operations:

1. Selecting suitable pasture crops.
2. Improving the yields of pastures.
3. Turning to pasture in spring.
4. Preventing bloat on pasture.
5. Supplying supplementary feed to cows being pastured.
6. Taking cows off pasture in fall.

1. SELECTING SUITABLE PASTURE CROPS

The selection of suitable crops is often overlooked. Many dairy farmers continue to use low-yielding permanent pastures when there is opportunity to change to higher-yielding crops.

Bluegrass pastures and other grass pastures often yield not more than one-half as much as some other crops. The use of a small acreage of permanent pasture, however, is very desirable even though most of the acreage consists of rotation or temporary pastures.

Procedure:

- A. Select high-yielding crops.
- B. Select best pasture crops for conserving soil fertility.

A. Select high-yielding crops. On tillable areas of the more fertile soils some of the higher-yielding legumes, such as sweet clover, alfalfa, red clover, and alsike clover, may be used to



FIG. 56. ALFALFA IS RESISTANT TO DROUTH

This picture shows one of the experimental alfalfa pasture plots at the University of Illinois in August of a dry summer. Rainfall during June was .47 inch and during July, 1.35 inches. Normal rainfall in this area is about 3½ inches monthly. The drouth resistance of this crop is one of its valuable attributes as a pasture crop.

advantage, whereas on the less fertile soils sweet clover and lespedeza should be considered.

One of the great mistakes in selecting pasture crops is that too much dependence is placed on only one crop. Alfalfa, for example, should not be pastured in the spring until it has passed the stage when it is very high in water content and is nearly ready for the first cutting of hay. In fact, many farm-

ers find that the best plan of using alfalfa for pasture is to harvest one crop of hay each season before the crop is pastured. Furthermore, the best method of pasturing alfalfa in the corn-belt states is not to pasture it continuously but to pasture it down quickly, that is, in ten days or two weeks, and then to let it rest until it makes a vigorous new growth. Managed in this way, it may be pastured three or four times during the season. By dividing a suitable area of alfalfa pasture into



FIG. 57. EXCELLENT EARLY SPRING PASTURE

Winter rye sown in corn fields in August or immediately following the harvesting of corn for silage provides a high-yielding spring pasture. The beneficial effects of early spring pastures on the health of dairy cows, particularly in promoting regular breeding, are now largely explained through the discovery that green-growing grass is much higher in its vitamin content than are most winter rations.

plots, the method of grazing just described may be employed and the cattle may be rotated from plot to plot to obtain continuous alfalfa pasture.

Biennial sweet clover dies out in July or August of the second year. Bluegrass often furnishes no feed during August. These are some of the considerations which have led to the plan of using a number of crops grown in separate fields or plots so that pasture will be available throughout the growing season.

Crops chosen for a pasture experiment at the University of Illinois¹ were winter rye, bluegrass, alfalfa, and a mixture of Sudan grass and soybeans. The winter rye and mixture of Sudan grass and soybeans were grown on the same plot. The rye was seeded in the fall after the pasturing of the Sudan grass and soybeans was completed. In the following spring it provided luxuriant pasture before the bluegrass had made sufficient growth. The rye was pastured for three to five weeks and the plot was then manured, plowed, and seeded to



FIG. 58. TWO PASTURE CROPS IN ONE SEASON

This picture shows dairy cattle grazing Sudan grass on the same field illustrated in Fig. 57. After the rye was pastured off, the field was plowed and seeded to a mixture of Sudan grass and soybeans. Sudan grass produces a large yield of forage and withstands dry weather well.

a mixture of soybeans and Sudan grass. Bluegrass was next pastured for two to four weeks, when alfalfa was ready. From this time on, the cattle were alternated between the alfalfa and Sudan grass plots. Bluegrass was not pastured again until late in the fall after rains had revived its growth. The use of these crops in the manner just described provided about twice as great returns per acre in terms of gain in weight of yearling heifers as did adjoining plots of bluegrass which were pastured continuously.

¹ Ill. Agr. Exp. Sta., 50th An. Rpt., 156, 1939.

Other combinations of crops, as well as mixtures and methods of seeding, are discussed in the reference books listed at the end of this chapter.

B. Select best pasture crops for conserving soil fertility. One of the important considerations in the selection of a pasture crop is the extent to which the crop conserves soil fertility. The legume crops aid in maintaining, and in some instances in increasing, the nitrogen content of the soil, and thus promote the growth of grasses in legume-grass mixtures. The yields of grasses in pastures are therefore greatly increased when legumes are introduced into grass pastures.

A thin stand of a pasture crop on sloping fields low in fertility permits erosion to proceed at a rapid rate. A dense sod, on the other hand, reduces erosion nearly to zero. Excellent discussions of the relation of kind of pasture crops to soil conservation may be found in the references appended to this chapter.

2. IMPROVING THE YIELDS OF PASTURES

The yields of unimproved pastures, as a rule, are extremely low. One method of increasing the yields is to inaugurate a well-considered plan of pasture improvement, and another is to change to a higher-yielding crop or to a combination of crops.

Improvement of permanent pastures usually involves the addition of fertilizer, including nitrogen and phosphorus and sometimes potassium also. The nitrogen is usually provided most economically by the seeding of legumes into the pasture or by the application of barnyard manure, including both the liquid and solid excrement, or by a combination of these procedures. The treatment of grass pastures with heavy applications of barnyard manure in the spring shortly before growth starts and again in the fall before growth ceases has been found one of the most effective procedures for increasing the

yields of grass pastures. Experiments with bluegrass pastures at the University of Illinois ² showed that the yields of heavily manured bluegrass plots were two to three times as great as those from untreated plots.

TABLE XXVII
EFFECT OF FERTILIZATION AND IRRIGATION ON YIELD
OF BLUEGRASS *

Year	Plot 9		Plot 10		Plot 6		Plot 5	
	Treat- ment	Yield †	Treat- ment	Yield †	Treat- ment	Yield †	Treat- ment	Yield †
1928	None	1052	None	1052	—	—	—	—
1929	None	2114	None	2114	—	—	—	—
1930	None	912	None	912	—	—	—	—
1931	None	1505	None	1505	N,P,K ‡	6954	N,P,K ‡	6954
1932	N	2906	N,K	2859	N	6559	N	6559
1933	N	5345	N	6198	N	9152	N	8690
1934	N	4476	N,P	5413	N	10139	N	9656

* From Mortimer and Ahlgren, J. Am. Soc. Agron., Vol. 28, p. 515.

† In pounds of oven-dried grass.

‡ N = Nitrogen; P = phosphorus; K = potassium. All treated plots were also irrigated by means of a hose.

Be sure that the manure applied as topdressing to pastures either is well rotted or does not contain large amounts of straw or other coarse material that may smother the grass. Harrow or spread with a fork any large chunks that may remain after the manure is applied.

For sanitary reasons the topdressing of pastures with manure should be done two weeks or more before the cattle are turned to pasture in spring and only after the cattle have been taken from the pasture in the fall.

² W. J. Fraser, Unpublished data.

3. TURNING TO PASTURE IN SPRING

Care must be used in turning cows to pasture for the first time. The pasture crop may be so young that pasturing it too early in the spring will seriously retard its growth during the summer. Digestive disturbances, bloat, and bad flavors in the milk may also result if care is not taken.



FIG. 59. SEEDING SUDAN GRASS FOR PASTURE

Emergency pasture and hay crops may be seeded without delay when modern machinery is used. Sudan grass seeded on this field following winter rye was ready for pasturing four to six weeks after seeding.

Examine the pasture crop carefully in all parts of the pasture, to see whether it is sufficiently well advanced to furnish good feed without injury to the tender plants. Cattle should not be turned to pasture as soon as the plants begin to turn green, for such a practice usually results in stunting the growth of the crop for several weeks and greatly reduces the yield

during the season. Furthermore, the plants, when very short during early spring, are more subject to injury by tramping.

Cows should not be left on pasture the entire first day, as a rule. Milk production will be better maintained and there will be fewer disturbances if the cows are allowed to get only a good fill each day for the first day or two. Therefore, remove the cows from the pasture at the end of two hours or as soon as they seem satisfied. When this practice is followed, it is necessary, of course, to give the usual morning feed each day before turning to pasture. After the first few days, leave the cows on pasture continuously, except during the milking hours.

4. PREVENTING BLOAT ON PASTURE

The bloating of cattle when on pasture is one of the drawbacks to the pasture method of feeding, as occasionally serious losses result from this cause. As a rule, more cases of bloat occur on legume pastures than on grass pastures. As an aid in preventing bloat, follow the simple precautions suggested below.



FIG. 60. SUDAN GRASS PRODUCES VERY LARGE CROPS

This picture of an experimental pasture plot shows some of the stalks of Sudan grass which had not yet been eaten. The crops of green forage produced by Sudan grass on this plot amounted to more than 10 tons in one season in addition to nearly that amount produced by winter rye grown on the same plot earlier in the season.

During the first three or four days the cows are pastured in the spring, give them their usual allowance of silage, hay, grain mixture, or other feed in the morning before turning them to pasture. Do not turn them to pasture the first time when the plants are wet from dew or rain. For the first two or three days, leave the cows on pasture only one to two hours



FIG. 61. A DORMANT BLUEGRASS PASTURE

This picture was taken on September 7, the same day as Fig. 62. Only a few dried-up stems of bluegrass remained. Because of the tendency of bluegrass to become dormant during hot, dry weather, bluegrass pastures may be supplemented advantageously by the use of pasture crops, such as Sudan grass, alfalfa, and sweet clover, which withstand dry weather more satisfactorily.

a day. After they are once accustomed to the pasture leave them on it continuously, except at milking times. Providing a supply of dry hay or straw in a feed rack to which the cows have access is a further aid in preventing bloat.

Legume pastures seem to cause bloat quite frequently after frosts in the fall. It may be necessary to discontinue the use of such pastures unless favorable weather brings new growth.

5. SUPPLYING SUPPLEMENTARY FEED TO COWS BEING PASTURED

Too often dairy cows are expected to obtain from pasture all the nutrients they require. Pasture forage is comparable

to the roughage portion of the ration. It was pointed out in Chapter VIII that high-producing cows can not obtain sufficient amounts of nutrients from roughage alone. Further, pastures usually decline in productivity during midsummer and furnish amounts of feed far less than the roughage portion of a good winter ration. As a rule, therefore, high-producing cows



FIG. 62. SUDAN GRASS MAKES AN EXCELLENT EMERGENCY PASTURE CROP

The Sudan grass shown here was planted during the latter part of May after the rye had been pastured off and the plot had been manured and plowed. The plot was pastured four times during the summer, the forage being grazed off almost completely each time. Rainfall during July totaled 2.43 inches and during August, .80 inch. The picture was taken September 7. Compare with Fig. 61.

need grain mixture when being pastured, and if the pasture becomes sparse, some roughage in addition.

Procedure:

- A. Determine character and amount of grain mixture necessary.
- B. Supply roughage when needed.

A. Determine character and amount of grain mixture necessary. The composition at different stages of growth of a number of pasture crops is given in Table XXVIII. Note that young grass is low in dry matter (high in water content) and

TABLE XXVIII

COMPOSITION OF PASTURE CROPS AT DIFFERENT STAGES
OF DEVELOPMENT

(Analyses calculated to basis of hay containing 15 per cent moisture)

Crop	Date of Harvest	Stage of Growth	Protein, Per Cent	Fiber, Per Cent	Ash, Per Cent
Alfalfa *	May 4	6½ inches high	23.8	10.5	10.4
"	May 18	8½ " "	20.6	12.5	9.9
"	June 1	18 " "	19.5	17.3	10.3
"	June 15	28 " " —buds	14.6	23.9	9.9
"	July 7	Full bloom	11.0	31.3	6.8
"	July 20	" "	9.9	34.4	6.9
Clover †	June 10	—	14.5	21.1	5.7
"	June 21	—	11.2	26.2	4.6
Kentucky bluegrass ‡	Apr. 23	Panicle just visible	16.90	15.67	6.86
" "	May 1	Panicle spreading	13.78	19.41	4.73
" "	May 21	Full bloom	10.72	20.20	7.06
" "	June 5	In seed	10.62	20.69	5.42
Orchard grass ‡	Apr. 23	Panicle not out	13.57	15.95	8.75
" "	May 4	Panicle closed	8.83	19.70	7.02
" "	May 13	Full bloom	8.10	21.59	6.86
" "	June 1	After bloom	7.01	23.17	7.66
Red clover ‡	Apr. 19	Head invisible	22.56	9.34	7.90
"	May 4	Head well formed	21.68	11.13	7.56
"	May 10	Full bloom	16.27	13.52	7.06
"	June 1	After bloom	15.38	16.92	6.16
"	June 8	In seed	12.95	16.24	6.25
Reed canary grass §	May 24	13 inches high	21.6	—	—
" " "	June 1	20 " "	19.4	—	—
" " "	June 8	30 " " , half-headed	15.3	—	—
" " "	June 15	40 " " , fully headed	12.4	—	—
" " "	June 22	50 " " , seeds ripening	11.2	—	—
" " "	June 29	50 " " , seeds ripe and falling	11.3	—	—
" " "	Aug. 21	Second growth	14.5	—	—
Sweet clover ||	Apr. 19	Tops— 310 lb. per acre	24.8	—	16.0
" "	Apr. 26	" —1100 " " "	28.0	—	10.4
" "	May 16	" —2690 " " "	20.4	—	14.2
" "	May 31	" —4260 " " "	18.6	—	8.6
" "	June 4	" —4770 " " "	16.5	—	9.7
Timothy †	June 12	Heads emerging	7.8	23.7	6.5
"	June 24	Early bloom	6.4	26.3	6.3
"	July 13	Straw color	5.1	26.6	5.7

* Utah Agr. Exp. Sta., Bul. 48.

† Ohio Agr. Exp. Sta., Bul. 576.

‡ Ill. Agr. Exp. Sta., Bul. 5.

§ Wis. Agr. Exp. Sta., Cir. 264.

|| Ohio Agr. Exp. Sta., Bul. 405.

that the dry-matter content increases rapidly as the plant develops. On the other hand, very young grass is high in protein, so high, in fact, that if the grass is dried its protein content is equal to that of wheat bran or other concentrates medium-high in protein. As the plant develops, the proportion of protein in the dry matter becomes lower and lower, although the protein content of the legumes does not become so low as that of the non-legumes.

A grain mixture suitable for use as a supplement to early spring pasture, therefore, need contain but a small proportion



FIG. 63. FIRST-YEAR SWEET-CLOVER PASTURE

Sweet clover seeded with oats made such a good growth on this central Illinois farm that it produced a large amount of pasturage in September of the same year.

of protein, and so may be made up largely of low-protein feeds, such as mixtures Nos. 1 to 6, Section 5, Chapter VIII.

After the grasses have headed out or are past the bloom stage, the protein content is much lower and the other nutrients are much higher in amount (in terms of the total dry matter) than when the grasses were young. Under these conditions grain mixtures containing about 15 per cent protein, such as Nos. 7 to 12, Section 5, Chapter VIII, form suitable supplements.

Grasses usually become very ripe and dry in seasons of prolonged absence of rainfall; so that if dried up pastures

furnish most of the roughage, grain mixtures such as Nos. 13 to 18, Section 5, Chapter VIII, may be needed. Legume pastures, however, seldom require as supplements grain mixtures containing more than 14 to 15 per cent protein.

In seasons of liberal rainfall pastures which are well managed with respect to uniform and regular grazing may continue to have a rather constant growth throughout the entire season. This often occurs in regions of high altitudes. Likewise, the autumn rains usually cause a fresh new growth of such grasses



FIG. 64. APPLICATIONS OF BARNYARD MANURE GREATLY IMPROVE THE YIELDS OF PASTURES

The dairy farmer has at hand large amounts of cheap and efficient fertilizer. Its real value is seldom appreciated, so that it is often poorly cared for. Applied to pastures, it is an effective way of increasing yields, resistance to weeds, and nutritive value of the forage.

as bluegrass which have been more or less dormant during the hot summer months. Under these conditions, that is, whenever the grasses are green and growing, the protein content remains high, thus making it unnecessary to feed a grain mixture containing more than 13 per cent protein.

To obtain greatest economy in feeding dairy cows during the pasture season, therefore, watch the condition of the pasture closely and choose an appropriate grain-mixture supplement.

Fresh, green, rapidly growing pasture crops are not only higher in protein and vitamin content than crops more advanced in development, but are also much more palatable. Further, when growing rapidly, more pasturage is available. Under such conditions the cows eat more and produce more milk than when the pasture crops are advanced in develop-



FIG. 65. FERTILIZED GRASS IS PALATABLE

Short posts mark small plots in this bluegrass pasture. The area just beyond the wire cage (which protects a small sampling area) was heavily fertilized with cows' urine. The cattle grazed the fertilized plot much more heavily than the surrounding pasture. Analyses of the grass showed that the fertilized grass contained one-fourth to one-third more protein than the untreated portion of the pasture.

ment. Hence the amount of grain mixture fed, as well as its nature, should be adjusted to the condition of the pasture. Suggestions for the amounts to be fed are given in Table XXIX.

Compute the amount of grain mixture needed by each cow, keeping in mind the rules given above, and make a chart to be

TABLE XXIX

SUGGESTED RATES OF FEEDING GRAIN MIXTURE TO DAIRY COWS
AT PASTURE *

Mixture Fed and Breed of Cattle	Amounts of Grain Mixture to be Fed Daily		
	Spring (Grass growing)	Early Summer (Grass maturing)	Late Summer (Grass ripe)
<i>Low in protein</i>			
About 13 per cent protein; mixtures Nos. 1-6			
Ayrshire, Holstein, Swiss...	1 lb. grain mixture to each 3 lb. milk over and above 30 lb.	.....	.....
Guernsey, Jersey.....	1 lb. grain mixture to each 2.5 lb. milk over and above 20 lb.	.....	.....
<i>Medium in protein</i>			
About 15 per cent protein; mixtures Nos. 7-12			
Ayrshire, Holstein, Swiss...	.....	1 lb. grain mixture to each 3 lb. milk over and above 25 lb.	.....
Guernsey, Jersey.....	.....	1 lb. grain mixture to each 2.5 lb. milk over and above 15 lb.	.....
<i>High in Protein</i>			
About 18 per cent protein; mixtures Nos. 13-18			
Ayrshire, Holstein, Swiss...	.....	.....	1 lb. grain mixture to each 3 lb. milk over and above 20 lb.
Guernsey, Jersey.....	.....	.....	1 lb. grain mixture to each 2.5 lb. milk over and above 10 lb.

* Adapted from Cir. 502, Ill. Agr. Exp. Sta.

placed near the scale or container used for weighing or measuring the grain mixture.

It is fully as important during the pasture season as during the barn feeding season that cows be watched carefully and given individual attention. Too often a cow continues to produce well as the result of the stimulation of good pastures but at the expense of her body tissue; unless this is guarded against by liberal feeding, her milk yield is likely to decline prematurely and be lower than expected during the succeeding lactation.

B. Supply roughage when needed. Fresh, green, growing pasture crops usually supply an abundance of forage unless the pasture is stocked too heavily. As a rule, it is not economical to offer dairy cows additional roughage when pastures are good. However, in midsummer it is often advantageous to supply some roughage, as well as grain mixture, to high-producing cows.

Forage crops harvested and fed in fresh, green condition sometimes prove to be economical supplements to pasture. Crops fed in this manner, termed soiling crops, are green corn, alfalfa, clover, oats and peas, sorghum, etc. As a rule crops such as these should be supplemented by suitable amounts of grain mixture. The feeding of green corn, for example, supplies roughage, but this crop is relatively low in protein and is inadequate as the only supplement to pasture in the feeding of high-producing cows.

Silage has a number of advantages over soiling crops as a supplement to pasture. Chief among the advantages are the smaller amounts of labor required daily during the summer in feeding the cows and the fact that the nutritive composition does not vary through the season as in the case of green crops. Its chief limitation, unless it is a legume silage, is the same as that of green corn, that is, a low protein content. The use of legume silage or silage made from nitrogen-fertilized grasses as a supplement to pasture feeding is one of the important developments of recent years. Surplus pasture and meadow

crops may be ensiled in the spring and fed during midsummer and early fall, and the silos then refilled in the fall with corn. These legume and grass silages supply much of the protein that otherwise must be furnished in the grain mixture.

Legume hay is one of the most satisfactory roughages for summer feeding during a period of pasture shortage. However,



FIG. 66. AN UNATTRACTIVE PASTURE

These cows are more interested in the photographer than they are in the rape pasture in which they stand. As a rule, rape is unpalatable to dairy cows, and if eaten within a few hours before milking time, it may impart a bad flavor to the milk.

good-quality legume hay is prized so highly for winter feeding that most dairy farmers endeavor to save it for that season and to provide ample summer roughage through improved pastures or through grass and legume silage.

6. TAKING COWS OFF PASTURE IN FALL

Too often cows are expected to obtain a large part of their roughage from pastures in which plant growth has nearly

ceased or from pastures which have become almost bare. The feed supply usually becomes small during periods of dry or cold weather and cows are likely to decline in milk flow unless given additional feed. Then too, heavy frosts may result in bloating of the cattle. Discontinue the use of the pasture when the feed supply becomes greatly reduced or after heavy frosts.

Pasture plants should be permitted to make a good top growth in the fall in order that they may store a reserve supply of food in the roots. When this is done, the plants are much less subject to winter killing and make a more rapid growth early in spring.

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COMMUNITY STUDIES

1. What kinds of grasses or crops are used for pasture? Does the pasture yield a large amount of feed? Could other crops be selected that would prove more satisfactory?
2. Is fertilizer of any kind applied to the pasture? Kind, time of application, and amount? Does the farm operator find the use of this fertilizer effective and profitable?

3. How tall is the grass when the cows are first turned to pasture?
4. Are cows fed in the barn in the morning before they are first turned to pasture? If so, is this done more than one day?
Kinds of feeds used?
5. Have any cases of bloat occurred while the cows were on pasture?
6. Are any precautions taken to prevent bloat? Procedures?
7. Are supplements to pasture supplied? If so, what kind? (Grain mixture, soiling crops, silage, hay?)
8. If grain mixture is fed, learn—
 - (a) The protein content, or proportion of feeds in the mixture.
 - (b) The rate at which the grain mixture is fed.
 - (c) Number of weeks during the pasture season when such feeding is done.
9. If soiling crops are used as supplement to pasture, learn—
 - (a) The kind of crops used.
 - (b) How the crops are harvested and how often.
 - (c) Where the crops are fed (barn, yard, or pasture).
 - (d) Whether or not the feeding of these crops has caused bloating.
 - (e) What quantity of each crop is fed daily.
 - (f) The amount of land required to furnish soiling crops for the herd; for one cow.
10. When silage is used as supplement to pasture, find—
 - (a) The kind and quality of the silage.
 - (b) Whether silage is the only supplement used or whether grain mixture or hay are fed in addition.
 - (c) The amount of silage fed per cow per day.
 - (d) The number of times daily the cows are fed silage.
 - (e) The method used to keep silage from spoiling.
11. For each of the farms visited, itemize the procedures which in your opinion might profitably be improved, and give your suggestions for the manner in which improvement might be made.

CHAPTER X

PRESERVING AND PREPARING ROUGHAGES FOR DAIRY CATTLE FEEDING

Improvement in the kind and quality of roughages fed to dairy cattle offers probably the greatest single opportunity for betterment of dairy-farm practices and dairy-feeding programs. Careful investigations by agricultural experiment sta-



FIG. 67. CRUSHING ALFALFA STEMS PROMOTES RAPID DRYING

This crushing attachment, which is hitched behind an ordinary farm mower, picks up the swath as it leaves the cutter bar and passes it between steel rollers under heavy pressure. The stems are flattened and crushed, thus causing the hay to dry more quickly than uncrushed hay. The mower may be drawn by tractor or team, and the crusher is operated by a gasoline motor mounted upon it.

tions and the teachings of agricultural high schools, agricultural colleges, and the farm press have brought about reasonably good practice in the feeding of grain mixtures to dairy cattle, but there remains a vast field for improvement in the nature of the roughage portion of the ration.

Thousands of acres of non-legume hay crops are being replaced with legume crops, but during the last half century

until within recent years little or no improvement in methods of making hay have taken place. Now new machinery and increased knowledge of nutritive factors furnished by well-cured hay have opened a new era in haymaking. Likewise, scientific discoveries of the relation of vitamins in well-preserved silage crops to animal feeding and of new methods of making silage from grasses and legumes are revolutionizing silagemaking and at the same time causing radical changes in cropping systems. These changes for the most part are in the interests of better soil conservation and thus tend to make dairy farming a more permanent and a more profitable industry.

Operations:

1. Selecting a suitable hay crop.
2. Harvesting hay to retain highest quality.
3. Choosing the crop to be ensiled.
4. Preparing the silo.
5. Ensiling corn.
6. Ensiling legumes and grasses.
7. Ensiling the sorghums.
8. Grinding roughages.
9. Fermenting roughages.

1. SELECTING A SUITABLE HAY CROP

It was pointed out in Chapter VIII that there are wide differences in the nature and in the feeding value of the various concentrated feedstuffs. Differences in the roughages are even greater.

Procedure:

- A. Select crop high in feeding value.
- B. Select crop suitable to region.
- C. Select crop suitable to farm.



FIG. 68. RAKING HAY WITH A SIDE-DELIVERY RAKE

Raking hay into windrows as soon as it has wilted helps to prevent the leaves from shattering and to preserve the green color. It also promotes more uniform drying. The sidedelivery rake not only gathers the hay ready for the hay-loader or sweep rake, but may also be used for turning the windrows frequently to promote rapid drying.

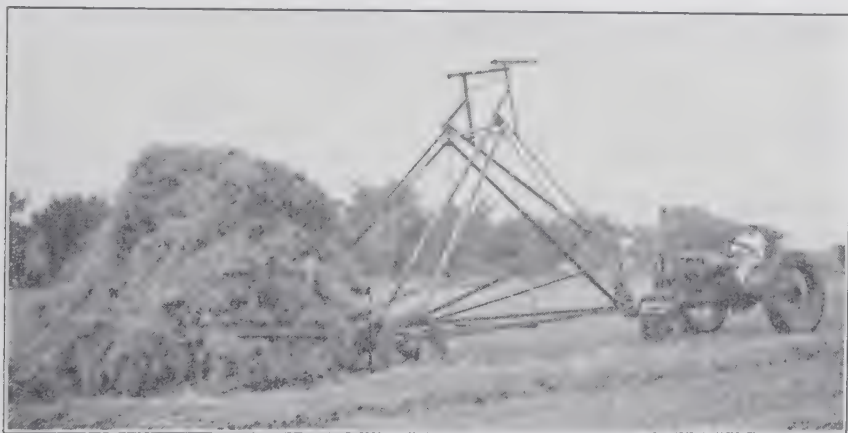


FIG. 69. MODERN MACHINERY SPEEDS HAY HARVESTING

This machine is provided with a sweep rake which is pushed ahead of the tractor to collect the hay from the windrow. The rakeful of hay is then raised a few feet and carried to a stack as shown in Fig. 70.

A. Select crop high in feeding value. In general, legume crops are superior in feeding value for dairy cattle on account of their high content of protein and lime. The value of legumes as sources of these nutrients may be illustrated by the statement that when dairy cattle are fed all they can eat of high-quality legumes, either as excellent pasture or as well-cured hay, little attention need be given the concentrated portion of the ration. In fact, under these conditions, if con-

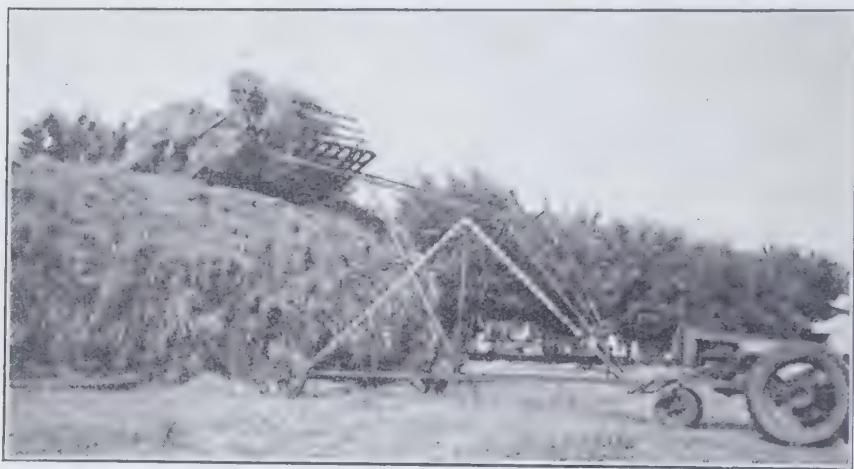


FIG. 70. PLACING A HALF-TON FORKFUL OF HAY ON A STACK

This is the forkful of hay shown in Fig. 69. The complete procedure of raking and elevating the load onto the stack is carried out by one operator without leaving his seat on the tractor.

centrates are needed at all, a mixture of corn and oats, or other farm grains, may be ample.

Some crops, such as Reed canary grass, and *Sericea lespeeza*, are distinctly unpalatable. Other crops, such as soybeans and sweet clover, when cured as hay, furnish palatable leaves but have such coarse stems that a high proportion of the hay is refused when it is fed liberally.

B. Select crop suitable to region. Consult the references given at the close of this chapter for a list of the forage crops adapted to the area in which you are located. It is possible that some legume crop not now grown in your locality might

do well if suitable soil treatments were applied. It would be foolish, however, to spend money for seed and to devote field area to a crop which definitely has been shown to be climatically unsuited to your area. For example, Korean lespedeza would make an exceedingly poor crop for New York or Wisconsin. On the other hand, the area over which alfalfa is grown has been increased through the application of suitable soil treatment and the use of varieties adapted to the region.

C. Select crop suitable to farm. Not only must the crop be adapted to the region but the conditions of your own farm must also be considered. Farms in northern regions that have poorly drained soils usually must depend upon grass crops rather than upon alfalfa or other legumes. However, alfalfa produces enormous yields under irrigation.

The cropping system, too, must be considered. It is often found when a crop is to be used only one year for hay and the following year for pasture that a mixture of crops is better than a single crop.

2. HARVESTING HAY TO RETAIN HIGHEST QUALITY

Practically all the carotene, the yellow pigment of plants which is converted by the animal into vitamin A, is provided for dairy cattle by the roughage. Yellow corn and its by-products contain some carotene, but the amount is small compared with that in green growing crops, green hay, and green silage. It is important, therefore, that hay be cured with the retention of as much as possible of its natural green color. The following procedures describe methods of haymaking which aid in retaining this green color and in producing hay having high-feeding value.

Procedures:

- A. Harvest crop at proper stage.
- B. Cure thoroughly in field.

C. Store as soon as cured.

D. Ventilate hay storage.

A. Harvest crop at proper stage. Proper stage for harvest is determined by a number of factors, including (a) stage at which the highest quality of product is obtained; (b) stage



FIG. 71. STACKING HAY IN THE FIELD PROMOTES GOOD CURING

Stacking hay in the field where it is produced helps to save the leaves and to promote uniform curing. Hay placed in well-made stacks usually has a better chance of being cured into a high-quality product than when stored in poorly ventilated mows. The illustration shows an "overshot" stacker.

which gives the greatest yield; (c) effect upon the succeeding crop.

As a rule, harvesting at an early stage of development of the crop gives a higher content of protein and carotene and less fiber than late harvesting. Not only is the protein content higher in early cut crops, but the digestibility of the protein also is higher. The digestibility of the fiber decreases as the plant approaches maturity.

A common rule for harvesting alfalfa is to cut when the plants have reached the tenth-bloom stage. Red clover and

alsike clover are commonly harvested at too advanced a stage for best-quality hay. The rule usually followed is to wait until one-third or more of the heads are dead, but harvesting in early bloom or in full bloom may yield hay nearly as high in protein content as alfalfa; whereas under the common procedure, the protein content of these clover hays is much less. Moreover, there is a much smaller wastage of coarse stems when early cut clover hay is fed. Alsike clover is best harvested at the full-bloom stage.

The first-year sweet clover crop makes better hay than the



FIG. 72. HAY STACKS EXPOSED TO THE WEATHER CAUSE HEAVY LOSSES

These small stacks are built around sharpened stakes set firmly in the ground. This method of curing and storing hay is used in the southeastern states where high humidity makes haymaking difficult. Much surface is exposed when stacks are small, therefore resulting in a high percentage of the hay's being spoiled by weathering.

second season's growth. It should be harvested in late fall to avoid injury to the plants.

Soybeans make the best quality of hay when harvested while the leaves are still green and before the seed has reached more than one-half normal size. However, at this stage there is a sacrifice in the yield per acre of the soybean crop.

Grasses like timothy and redtop are usually harvested at too advanced a stage for high-quality hay. Often these are not cut until after all blooms have fallen, but hay much superior in protein content and in palatability can be made by harvesting timothy before bloom or in early bloom. Redtop should be cut when the heads first appear above the boot.

Oats and wheat are ready for hay harvest when the grain is in the milk stage.

B. Cure thoroughly in field. As a rule, hay which is to be stored in the loft, or mow, of an ordinary barn must have not more than 20 per cent moisture if it is to become good-quality hay. With a high moisture content at time of storage, high temperatures usually occur, causing brown or even blackened hay. Sometimes temperatures become so high that spontaneous combustion occurs with the loss of the barn and its contents. As a rule, when the moisture content at



FIG. 73. WELL-COVERED HAY STACKS

When hay is stacked, much loss in feeding value may be prevented by the use of well-made covers. The temporary covers illustrated will protect stacks for several months. Heavy weights are necessary to prevent the covers from being blown off.

time of storage is 30 per cent or more, either molding occurs or a mustiness develops. When this hay is removed from the mow, it is usually very dusty. Brown, moldy, and musty hay are lower in carotene content and in palatability than properly cured hay that is high in green color.

Experience is needed in determining when the stage of 20 per cent moisture is reached. To aid in learning the character of hay at this stage, dry several samples, one at a time, in an oven over night. To facilitate drying, use shears and cut the hay into pieces two or three inches in length. Spread in a thin layer in baking pans. Be careful to keep the tem-

perature low enough to prevent charring of the sample (not over 220° F.). A sample containing 20 per cent moisture should lose exactly one-fifth. In other words, a four-pound sample after drying should weigh 3.2 pounds. If the loss is more than this, the hay is too high in moisture to make the best-quality hay.

Hay cured in the swath is likely to become brittle with a resulting loss of leaves and the production of hard, wiry stems. Place in windrows early, using either a windrower attachment



FIG. 74. BALING HAY WITH A PORTABLE BALER

Baling hay in the field puts it into convenient form for storing, feeding, or shipping. Care must be taken, however, that the hay is thoroughly cured or else the hay is likely to mold.

to the mower or a side-delivery rake. Turn the windrows frequently to promote rapid and uniform drying.

C. Store as soon as cured. Several different methods of handling and storing hay are in use, including (a) storing loose in mow; (b) storing loose in stack; (c) baling in field; (d) chopping at barn or in field.

(a) *Storing loose in mow.* This is the most common method of storing hay and is adapted to farms of all sizes. A minimum amount of haying equipment is needed, but of course a considerable investment in buildings is involved. The usual equipment consists of mower, side-delivery rake, hay loader,

and unloading equipment consisting of either hayfork or hay slings. The use of hay slings saves much time as compared with the hayfork method.

As soon as the hay is dropped into the mow from the fork or slings it should be spread by hand to facilitate uniform drying and to make easier its removal at feeding time. The addition of salt increases palatability but has little or no effect on curing.



FIG. 75. THE PICK-UP BALER EXPEDITES HAYMAKING

This machine picks up hay from the windrow and bales it. Ten to 15 bales at a time are collected on a trailer attached to the baler and then dumped in piles in the field to be picked up later by wagon or truck.

(b) *Storing loose in stack.* Stacking in the field is a time-saving operation for the rapid storing of hay. A number of different kinds of stackers are in use. As a rule, hay containing somewhat more than 20 per cent moisture may safely be stacked provided the stack is not large. For large stacks, it is best to keep the moisture content at a level close to 20 per cent. Field stacking is one of the simplest and most certain methods of producing high-quality hay.

To prevent excessive loss by weathering, especially in the case of nongrass hays, like alfalfa hay and clover hay, cover

the stacks with one or more loads of spoiled grass hay, or weeds, or apply a temporary cover.

(c) *Baling in the field.* The use of the pick-up baler for baling hay directly from the windrow saves much hand labor as compared with storing loose in the mow. Often the quality of the hay is poorer, however. Pick-up balers involve a considerable investment and are usually owned by commercial operators who must use them as much as possible in order to



FIG. 76. CHOPPING HAY IN THE FIELD SAVES MUCH HAND LABOR

This machine picks up the hay from the windrow, chops it, and blows it into a covered wagon or truck. At the barn, a blower elevator delivers and spreads the hay in the mow. With this method of harvesting, hand labor is eliminated to a great extent.

realize a satisfactory return on their investment. For this reason hay is often baled before it is properly cured or when damp from dew or rain.

Portable balers are often used for field baling, the hay being brought to them either on a wagon, after having been loaded by means of a hay loader, or by a sweep rake.

Field-baled hay may be stored in the mow of a barn or under an open shed. Sometimes baled hay is placed in ricks at the side of the field and temporary covers provided. When hay is baled in the field and stored where it is well ventilated,

such as under an open shed, it may safely contain somewhat more than 20 per cent moisture at the time of baling. Proper storage of field-baled hay consists of ricking the bales on edge and leaving a few inches space between the tiers of bales. If the tiers are more than four bales high, they should be cross-tied, that is, some of the bales should be placed crosswise to prevent their tipping or settling against each other.

(d) *Chopping at barn or in field.* Some farmers prefer to store hay in chopped form. The advantages of this method,



FIG. 77. MOWING A HEAVY CROP OF LESPEDEZA

This short, dense-growing crop of Korean lespedeza produced about $1\frac{1}{2}$ tons of hay to the acre. The mowed swaths in the immediate foreground are so dense that they stand nearly as high as the unmowed portion of the field.

as compared with storing long or uncut hay, are: (1) a saving in storage space, since chopped hay occupies about half as much cubic space per ton; (2) greater convenience and a saving of labor in feeding; (3) less hay refused by the cattle; (4) with some types of harvesting machines, much less labor in harvesting and storing.

The equipment used for chopping hay may be silo fillers or specially built hay choppers which are stationed at the barn or other storage place and which blow the chopped hay into the loft or storage bin. Machines which pick up the cured

hay from the windrow, chop it, and elevate it onto a wagon or truck in one operation are on the market. Such equipment makes the harvesting of hay almost entirely mechanical and makes it possible to handle a large tonnage of hay daily with a crew of two or three men.

Successful storing of chopped hay necessitates thorough curing in the field to a moisture content of 20 per cent or less, because chopped hay packs closely and is likely to become brown or moldy unless thoroughly dry.



FIG. 78. BRINGING LESPEDEZA HAY TO THE BALER

Usually the crop is raked the same day it is mowed, and baled the next day. The stems are so fine and so low in moisture content that rapid curing is possible. This two-mule rake outfit and the driver keep the baling crew busy.

D. Ventilate hay storage. Soon after hay is placed in a mow, stack, or bale, it goes into a "sweat," or fermentation process. The temperature rises and moisture is given off. The sweating process may last from a few days to three or four weeks, depending upon the amount of moisture in the hay, the tightness of packing and the facilities for ventilating the hay. Hay in tightly closed hay mows and large stacks remains in a sweat for a longer time than when facilities are provided for a ready escape of moisture. Hence, it is desirable, as a rule, to use all available means at hand to promote rapid drying of the stored hay.

In storing hay in a mow, it is best to spread the hay over the entire area of the mow rather than to fill one bent or one end of the mow at a time. Doors and windows should be kept open to provide ventilation.

In stacking hay, stacks are best made not more than twelve feet in width and rectangular in shape. In making such a stack, lay out the bottom about ten feet in width and, when two or three feet above the ground, widen to twelve or thirteen feet to form a drip, or eaves. Then gradually draw in the sides and bring to a top not over four or five feet in width.



FIG. 79. BALING LESPEDEZA HAY

This portable baler is moved to various points in the field and the hay from an area in the immediate vicinity brought to it. Seventy-five to 100 bales are made before moving to a new location.

Special means of ventilating hay mows and chopped hay storage bins may be provided. The installation in hay mows of a number of simple vertical vents two by two feet to four by four feet in cross section and constructed of wood slats has been found to aid considerably in promoting rapid drying. In constructing metal storage bins, or "hay keepers," vents or ducts are usually built into the walls.

A forced draft-ventilation system in which only outside air is used as the drying medium was developed by the Tennessee Agricultural Experiment Station and the Tennessee Valley Authority. In this plan, a series of wooden ducts, or flues, is built on the floor of the hay mow with openings

next the floor. Outside air is forced through the system at a rapid rate by a power-driven fan and is forced upward through the hay. When a barn is provided with this equipment, it is possible to store hay having up to 45 per cent moisture and to dry it into high-quality hay at a low cost of operation.

The advantages of this plan may be summed up as follows: (1) hay may be taken from the field much sooner than when it remains in the field to reach a 20 per cent moisture content, thus helping to avoid loss by rains; (2) handling the hay

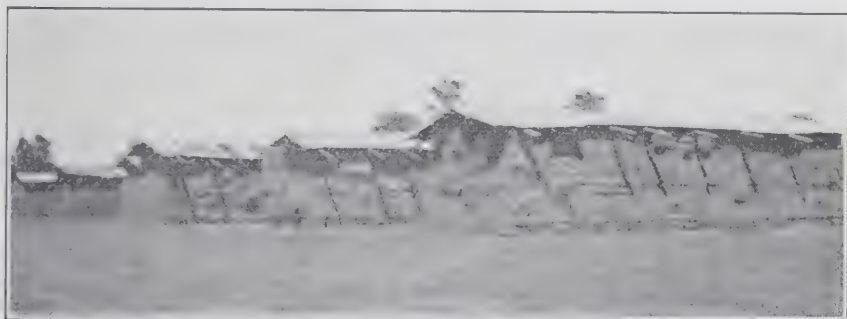


FIG. 80. BALED LESPEDEZA HAY GOING THROUGH THE FINAL CURING

These ricks of baled lespedeza hay are permitted to stand in the field under cover for 2 to 4 weeks so that the hay becomes thoroughly dried out. In making the ricks, posts or timbers are first placed on the ground and the bales are stacked on edge with several inches of space between them to permit free circulation of air.

when it has a high moisture content prevents shattering of the leaves; (3) the carotene content is well preserved. The development of this method of curing hay is likely to prove one of the most important contributions to modern methods of haymaking.

Artificial drying of freshly harvested hay is employed commercially in the making of alfalfa meal and on a few large, specialized farms. An important advantage of this method is that the hay is cured with little loss of carotene, but a disadvantage is that vitamin D is not enhanced through exposure to the sun as is hay cured in the field. The method is useful in humid regions where haymaking by ordinary

methods is hazardous. Present equipment for artificial drying involves a large investment in machinery, and the cost of power and fuel for each ton of hay dried is too great for most farms.

3. CHOOSING THE CROP TO BE ENSILED

A number of considerations influences the choice of a crop for silage purposes.

Considerations:

- A. Yield of nutrients to the acre and ease of harvest.
- B. Weather conditions at time crop is harvested.
- C. Availability of labor and equipment.

A. Yield of nutrients to the acre and ease of harvest. In the corn-belt states and in other areas where corn yields well, more nutrients per acre are obtained from corn than from most other crops. Because of its few failures as a crop, because of the development of suitable machinery for its culture and harvest, and also because it is readily preserved as silage without the addition of any preservatives, corn has been for many years the most extensively used silage crop in the United States. However, corn is a low-protein crop and is costly to grow in sections where much labor or much fertilizer is needed.

In some of the southwestern states, the sorghums and the kafirs are more satisfactory silage crops than corn on account of larger yields to the acre. The same consideration applies to the sunflower crop when grown in some of the semiarid regions of the northwest, where both low rainfall and early frosts are factors. In seasons of extreme drouth, weeds, such as Russian thistles and wild sunflowers, have been almost the sole source of forage in some areas and have been used satisfactorily as silage crops.

B. Weather conditions at time crop is harvested. Not infrequently, in spring at the time of harvesting the first cutting

of alfalfa and in fall at the time of harvesting soybeans for hay, the weather is so rainy and cool that making hay is very difficult. Besides, much hay is entirely spoiled and the hay saved is often of poor quality. Under such conditions, making silage from these legumes, as well as from other legume crops and sometimes from the grasses, may be a means not only of saving the entire crop but of making silage considerably higher in protein and in carotene content than corn silage. In some seasons it may be desirable to ensile the first cutting of alfalfa for summer feeding and to fill the silo with corn in the fall.

C. Availability of labor and equipment. Unless a special forage harvester which picks up and chops the crop in one operation is used, the labor involved in ensiling alfalfa and similar crops is large and probably greater than the amount required for haymaking. The need for labor in caring for other crops at that season may make it impracticable to ensile crops which are usually cured for hay.

4. PREPARING THE SILO

Leaks around the doors and through cracks in the walls frequently cause the spoiling of large amounts of silage. The silo itself may deteriorate rapidly if the walls are not given proper care. These matters should be given attention before the silo-filling season arrives.

Brush down and remove all chunks of dried silage adhering to the walls, together with any rotted silage or filth from the floor of the silo.

See that all doors are on hand and repair those not in good condition. In case the doors do not fit tightly, tack strips of felt, such as those commonly used in weather-stripping windows, to the edges of the doors which come in contact with other doors and with the walls.

If necessary, treat the walls of the silo. The action of the acid of silage destroys some of the cement of the walls

or mortar joints of silos. The mortar joints of tile and brick silos may shrink a very little with the formation of tiny cracks which permit some air to seep through into the silo. If the wall of a concrete silo has become rough, a cement-plaster coat may be necessary to smooth the surface and permit even settling of the silage without air pockets. The use of coatings of asphalt emulsions or asphalt-chromate emulsions have been found effective in cement and tile silos for periods of two to four years. Coatings of synthetic resins are said to have given good results. Before applying any of these materials, clean the walls thoroughly by means of scraper and wire brush and obtain directions for application from the manufacturer or from your agricultural experiment station.

5. ENSILING CORN

The keeping qualities of the silage, as well as its nutritive value, are to a large extent dependent upon the stage of development of the corn at the time it is put into the silo. Unless care is used to insure correct condition of the corn and proper methods of storing in the silo, the entire mass may spoil and be unfit for feeding.

Procedure:

- A. Determine when the corn is ready for harvest.
- B. Use necessary precautions in harvesting and storing.

A. Determine when corn is ready for harvest. When corn approaches the ripening stage, two or three days of hot weather usually make a great change in the moisture content of the plant and the ripeness of the ears. It is best to allow the corn to become as ripe as possible while still retaining green leaves and a large amount of water in the stalks. Silage made from corn that is a little too green will be better than that made from corn that is too ripe. Dent varieties of corn, grown in regions where the grain usually matures, are ready for the silo

when two-thirds of the ears have well-dented kernels, but it usually does no harm to allow nearly all the ears to become well dented, provided the leaves are still green.

If there is doubt regarding the readiness of corn for harvest, make determinations of its dry-matter content. To do this,

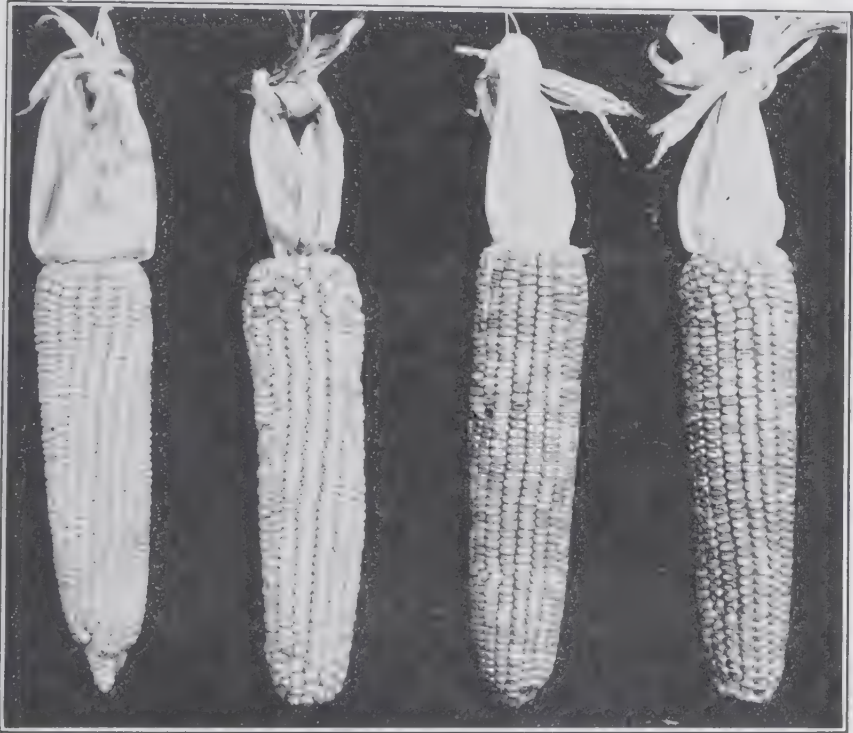


FIG. 81. EARS OF CORN AT DIFFERENT STAGES OF DEVELOPMENT

The ear at the left is too immature for good silage, and that at the right is too mature. The best stage of development for silage is when the majority of the ears are as far advanced as the second ear from the left, and no more mature than the second from the right.

select eight to ten plants representing as nearly as possible the condition of the corn in the field. Cut into small pieces by means of a corn knife. Mix thoroughly. Weigh out on a milk scale to one-tenth pound a 3- or 4-pound sample. Spread in baking pans and dry overnight in a hot oven, but do not permit the temperature to be high enough to char the sample

(not over 220° F.). Weigh the dried sample. The weight of the dried sample divided by the fresh weight and multiplied by 100 gives the percentage of dry matter.

Corn having a dry-matter content ranging from 30 per cent to 35 per cent makes the best silage. If the dry-matter content is less than 30 per cent, the crop may be allowed to mature more fully before harvesting, provided the season permits.

In northern states, the time of filling silos is largely governed



FIG. 82. MODERN MACHINERY SAVES MAN LABOR

The equipment shown here harvests standing corn, chops it into short lengths, and elevates it into the truck. Thus the usual labor of loading bundles onto a wagon is eliminated, and unloading is accomplished in a shorter time. As a rule fewer ears are broken from the stalks and left on the ground than when the ordinary bundle-corn harvester is used.

by the approach of frosts that threaten to kill the corn. Frozen corn does not make high-quality silage.

B. Use necessary precautions in harvesting and storing. Several different machines are used for harvesting corn. The most common is the corn harvester, which cuts the corn, binds it into bundles, and drops them on the ground in lots of three or four. Some harvesters have an elevator attachment which elevates the bundles to a wagon or truck driven alongside. The use of a field harvester, which harvests and chops the corn in one operation and elevates the cut corn onto a wagon

or truck, may reduce the size of the crew needed to one-half or less.

The corn should be cut into pieces not more than one-half to three-fourths of an inch long. This makes it possible to pack the corn closely in the silo.

For efficient cutting, the knives of the machine must be sharpened frequently. Dull knives permit dry husks to go through uncut and this prevents close packing. Dry corn, coarsely cut, often contains air pockets which permit the development of moldy spots.

It is necessary that the cut corn be packed solidly in the silo. A sectional distributor pipe attached to the end of the blower pipe is the best means for spreading the corn. Keep this constantly in use as long as the silo filler is operated, and spread the corn evenly. If the corn being ensiled is very high in moisture and is cut finely, little attention need be given to spreading and tramping it; but, if it is high in dry matter, it is essential that it be carefully spread and tramped thoroughly.

Well-dented corn with leaves ripe or fired may contain more than 35 per cent dry matter. Such corn does not pack well in the silo. Air pockets may be left, and mold forms all through the silage. Molds do not grow in the absence of air; hence, the presence of moldy silage indicates that air had access to that area or was enclosed in a pocket at that point. This difficulty in the packing of overripe corn may be overcome by the addition of suitable quantities of water (Table XXX). This is best added through the blower or distributor pipe. The addition of water to the corn after the silo has been filled rarely proves satisfactory, since the water seeps down next the walls and seldom penetrates to the center of the silage.

A common source of trouble in filling silos is air leakage around the doors. To prevent this difficulty, apply a roll of single-ply roll roofing. Place a broomstick through the roll, attach a rope near each end of the stick, and fasten the rope

to the door frame of the silo. As the silo is filled, unroll the roofing upward against the doors, leaving it in one piece, from bottom to top of the silo. The usual length of the roofing in a roll is 36 feet, which is sufficient for an ordinary silo.

Surface spoilage in silos not opened for feeding for several months can be reduced by covering the silage with roofing or

TABLE XXX

AMOUNTS OF WATER TO BE ADDED TO CORN BEING ENSILED
IN ORDER TO MAKE GOOD SILAGE

Dry-matter Content of Corn, Per Cent	Amount of Water to be Added to Each Ton of Corn Ensiled		
	Cubic Feet *	Gallons	Pounds
30 or less	00	00	00
35	5.3	40	333
40	10.6	80	666
45	16.0	120	1000
50	21.3	160	1333

* One cubic foot of water weighs 62.5 lb., and one gallon weighs 8.32 lb.

heavy paper treated with crankcase oil. To apply, stop the silo filler before the last two or three loads are put in, level the corn, and tramp it thoroughly. Starting at the side of the silo farthest from the blower, spread strips of roofing or paper, lapping the joints four to five inches and turning up the ends against the walls to the same height. Then apply the last two or three loads of corn, being careful not to walk on the roofing. Instead of corn, other materials such as dry earth, ground limestone, or sawdust may be used. These may be sacked and stored at the top of the silo when the silo is opened.

The amounts of material required for treatment of the surface in this manner are: for a 12-foot silo, $1\frac{1}{2}$ rolls of roofing;

for a 14-foot silo, 2 rolls of roofing; for a 16-foot silo, $2\frac{1}{2}$ to 3 rolls of roofing.

Special methods are used in filling trench silos and in protecting the surface from spoilage. Unchopped forage may be ensiled with good results provided it is thoroughly packed. A common method of packing is to use trucks for hauling the crop and to drive the truck over the forage already in the trench. Wagons or tractors may also be used. The covering usually consists first of a layer of straw or other dry roughage followed by a four- to six-inch layer of earth well rounded to shed water.

6. ENSILING LEGUMES AND GRASSES

Recent experimental work has shown that many crops other than corn, including alfalfa, the clovers, soybeans, timothy, Sudan grass, and the sorghums, may be successfully ensiled provided the proper precautions are taken.

Procedure:

- A. Be sure crop contains proper dry-matter content.
- B. Add preservative.

A. Be sure crop contains proper dry-matter content. One of the principal precautions in making legume or grass silage is to be certain that the crop has a satisfactory dry-matter content. For corn, sufficient moisture (65 to 70 per cent) must be present to insure good keeping qualities, but an excess is not especially harmful. However, when legumes or grasses are ensiled at too early a stage of development, the silage is likely to be soggy, to have a bad odor, and to be unpalatable. Therefore, allow legume and grass crops to approach the usual haying stage before harvesting. The farm-work program may make it desirable to harvest before this stage, however, and when this is the case, the percentage dry-matter content of the crops may be increased by allowing them to wilt in the field for three to five hours or more before ensiling.

Avoid ensiling the crops when a large amount of rain adheres to the foliage, because this water may lower the dry-matter content of the silage below the proper amount. On the other hand, the crop must not become too dry. Legume and grass crops harvested when mature enough for hay may be ensiled immediately after mowing, provided that no juice exudes from the silo. The escape of juice indicates that the crop should be



FIG. 83. MODERN MACHINES AID IN HARVESTING GRASS AND LEGUME SILAGE CROPS

This machine harvests standing alfalfa, chops it, and loads it onto a trailer wagon. Much hand labor in handling a heavy crop is thus avoided. One of the drawbacks to this method, however, is that the crop is likely to be so high in water content that the silage may be soggy and unpalatable. Also, under these conditions, juice may be lost from the silo.

permitted to become more mature or should be wilted before ensiling.

B. Add preservative. Legume and grass crops usually contain insufficient sugars or other water-soluble carbohydrates to promote the usual bacterial fermentation, which in the case of corn produces lactic and acetic acids equivalent to 1 to 2 per cent of the weight of the silage. When this amount of acid has been produced in any kind of silage, further bacterial action is inhibited and the silage is preserved by the acid. If the silage is not exposed to the air it may remain in excellent condition for many years. However, in most in-

stances, legume crops and also most young grass crops high in protein content undergo protein decomposition with evolution of foul odors, because acid is not produced rapidly enough or in large enough quantities to stop this kind of bacterial action.

Several methods for the successful ensiling of legume and grass crops have been developed. A brief description of each follows.

(a) *Molasses, or sugar method.* Very good results are obtained by this method and it is probably the most popular of all methods for preserving legume or grass silage. Its use greatly reduces the likelihood of spoiled silage as compared with ensiling these crops untreated. The amounts of molasses needed to insure good keeping qualities are:

Crop	Molasses per Ton of Crop
Grasses or cereal crops.....	40 lb. ($3\frac{1}{2}$ gal.)
Mixed grasses and legumes.....	60 lb. (5 gal.)
Alfalfa or clovers.....	80 lb. (7 gal.)
Soybeans.....	100 lb. ($8\frac{1}{2}$ gal.)

Blackstrap molasses, corn molasses, or beet molasses may be used. The use of powdered whey is an effective method and this by-product may be substituted for molasses at the rate of 90 pounds of powdered whey for 100 pounds of molasses.

The molasses may be added by permitting it to flow by gravity from an elevated drum into the center of the blower of the silo filler. It may be diluted with equal parts of water to facilitate its flow or used in undiluted form. Some silo fillers are equipped with molasses pumps to draw the molasses from drums into the machines.

(b) *Mineral-acid method.* Phosphoric acid used at the rate of 10 to 20 pounds of acid to a ton of green crop is an effective method of preserving legume or grass silage. It may be applied in the same manner as molasses but, because of its slightly corrosive action, care should be taken in handling

it and in removing traces of acid from the machine at the close of each day's run. Operation of the machine for a



FIG. 84. TWO SILAGE CROPS FROM ONE FIELD IN THE SAME YEAR

The silo at the right was filled in May with alfalfa. The alfalfa field was then plowed and planted to corn. The illustration shows the corn's being put into the silo in September, the alfalfa silage having been fed during the summer. The corn being unloaded was harvested with the equipment shown in Fig. 82. The cans at the left are used to collect samples of corn so that dry-matter yields of experimental corn plots can be determined.

short time after flow of the acid has been stopped is usually sufficient to remove traces of the acid.

Another acid method, known as the A.I.V. process, and given this name from the initials of the inventor, Mr. A. I. Virtanen of Finland, involves the addition of sulphuric and hydrochloric acids. Because the acid has a corrosive action on metals, it is usually introduced into the silo by means of a special pump and rubber hose. The acid is also harmful to clothing and may cause serious burns to eyes or skin. The method is patented and permission to use it must be obtained from the holder of the patent rights. When A.I.V. silage is fed, the cows should be supplied with large amounts of legume hay or with four ounces of ground limestone

per head per day to neutralize the effects of the acids on the cows' bodies.

Advantages claimed for the phosphoric-acid method are: (1) this acid helps to supply some of the phosphorus needed by dairy cows; and (2) the phosphorus content of the manure

is increased. The acid methods are very effective in preserving the carotene content of the silage crop and for this reason are favored by some dairymen who desire to produce milk high in vitamin and carotene content. The molasses method properly used is also effective for this purpose, however.



FIG. 85. SWEET CLOVER MAKES GOOD SILAGE

The operator of this farm, shown at the silo filler, found that sweet clover allowed to wilt in the field until the dry-matter content had reached 30 per cent and then ensiled with ample amounts of molasses made good-quality silage for winter feeding. Previously he found that sweet clover ensiled directly from the field lost large amounts of juice which caused a bad odor in the barn. Wilting before ensiling corrected this difficulty.

(c) *Mixed with crop high in fermentable carbohydrates.* Corn and the sorghums contain so much fermentable carbohydrate that, when they are mixed with grass or legume crops at rates of not less than fifty parts of corn or sorghum in one hundred parts by weight of the mixture, satisfactory silage is produced, provided, however, that the usual precautions described in the foregoing sections of this chapter are followed.

(d) *Untreated method.* Legumes and grasses harvested when their dry-matter content is 30 to 35 per cent or when allowed to wilt after mowing until their dry-matter content has reached this level, sometimes may be ensiled satisfactorily without preservatives, provided the cut material is thoroughly packed in the silo. However, better results are likely to be obtained from the use of the molasses or acid methods than from ensiling untreated grass or legume crops.



FIG. 86. PEA-CANNERY REFUSE MAKES GOOD SILAGE

The vines and empty pods which come from this equipment, known as a *viner*, are stacked and become silage. The outer part of the stack spoils, but the inner portion has a feeding value comparable with that of corn silage.

(e) *Dry-Ice or solid carbon dioxide method.* Dry Ice has been experimentally used as a silage preservative but the method is likely to be expensive and seems to have no advantages over the molasses and acid methods.

7. ENSILING THE SORGHUMS

As already indicated earlier in this chapter, the sorghums make very satisfactory silage crops in the southwestern states. In recent years many of the sorghums, including the sorgos, kafir, and grohoma, have been used as silage crops in place of corn in a number of the corn-belt states. As a rule, the sorghums do not mature when grown in the northern part of the United States, and if used for silage in that area are likely to be ensiled when both moisture content and fermentable-

carbohydrate content are high. The resulting silage is sour, soggy, and unpalatable. A much better grade of silage can be made from a mixture of corn and sorghum than from immature sorghum alone. A common practice is to plant two rows of corn alternately with two rows of sorghum and to mix these crops well at the time of ensiling. Also, if immature sorghum alone is used, wilting the crop after cutting for a half day or more may be beneficial.

8. GRINDING ROUGHAGES

Investigations have shown that the grinding of hays, such as alfalfa and soybean hay, does not increase the completeness of digestibility. The digestive system of the dairy cow, through the process of chewing, of mixing coarse feeds with large amounts of liquid, of remastication (chewing the cud), of bacterial action (fermentation), and finally through chemical action of the digestive enzymes, seems to be especially well adapted to the digestion of large amounts of coarse, bulky feeds.

The grinding and also the chopping of coarse feeds, such as the hays and corn stover, however, does increase the proportion of the roughage consumed by dairy cows. Ground



FIG. 87. BROOMCORN YIELDS LARGE AMOUNTS OF FORAGE WHICH MAY BE USED FOR SILAGE

After the brush is harvested for broom-making, the remaining forage, often amounting to 8 to 10 tons to the acre, is usually plowed under. Experiments at the University of Illinois showed that a fairly good grade of silage can be made from the forage when adequate amounts of molasses are added at the time of ensiling.

roughage is usually completely consumed, but this is also true of the best grades of fine-stemmed hays. On the other hand, coarse roughages, such as soybean hay and corn stover, when fed in whole form are often refused to the extent of 10 to 33 per cent. The refused parts, consisting of the coarsest parts of the plants, are very high in fiber and low in digesti-



FIG. 88. GROHOMA BEING GROWN IN ILLINOIS FOR SILAGE

Like many other plants of the sorghum family, grohoma finds its greatest usefulness in the semiarid districts of the Southwest where it withstands temperature and moisture conditions better than corn. As grown in the corn belt, several plants of this family produce large tonnages of forage which is high in sugar and water content and therefore makes silage of good keeping qualities.

bility and nutritive value. In experiments conducted at the Illinois Agricultural Experiment Station,¹ dairy cows refused 14 per cent of soybean hay fed whole but only 2 per cent of the same kind of hay after grinding. Although the apparent saving was 12 per cent of the hay fed, it was calculated that the gain in feeding value was much less on account of the low nutritive value of the stems, and amounted to only 5 per

¹ Ill. Agr. Exp. Sta., 40th An. Rpt., 148. 1927.

cent of the value of the hay. Based on this finding, one could afford to pay for grinding soybean hay only 5 per cent of its market value.

The grinding of hay and the feeding of it dry has several drawbacks. The dust which arises may cause irritation of the nasal passages of the persons doing the work, and the dust is objectionable in barns in which high-grade milk is being produced. Often grain and roughage are ground together, thus reducing the dust somewhat, but such a mixture cannot readily be fed in accordance with the needs of dairy cows producing moderate to large amounts of milk, for economical feeding practice requires that such cows be fed about the same amounts of roughage each day and that the quantities of grain mixture be changed with changes in milk yield. Some barns are equipped with feed rooms in which the ground hay may be placed in carts and thoroughly moistened with water before it is brought to the stable where it is fed. This procedure is effective in keeping the dust to a minimum.

The manure from cows fed soybean hay having well-developed beans usually shows some whole beans. Would grinding of the hay be warranted in order to prevent this loss? A fairly accurate answer may be obtained from the following procedure. Feed the same weighed amount of hay daily to a cow; after the fourth or fifth day save and weigh all the manure she drops in 24 hours; take a representative weighed sample of the manure amounting to 2 or 3 pounds; place the sample on a sieve or window-screen wire; wash away all but the beans; dry the beans and weigh; calculate the weight and value of the beans excreted daily. The amount of beans passing undigested into the manure is likely to be overestimated unless an actual test is made, such as the one suggested above. A pound of a large-seeded variety of soybeans contains about 2000 beans, whereas small-seeded varieties have 3000 to 5000 beans to the pound.

9. FERMENTING ROUGHAGES

The addition of substances, such as yeast or malt, to either whole or ground roughage in order to increase the completeness of consumption and digestibility is of doubtful value. Although somewhat larger amounts of feeds so treated may be consumed, the results seldom warrant the additional labor and investment in equipment and materials. Such treatments, of course, do not increase the protein content of the feed beyond the amount of protein in the yeast, malt, or other substances added. If heat is applied to hasten the fermentation or conversion process, the digestibility of the protein may be lessened.

TABLE XXXI

APPROXIMATE CAPACITY OF SILOS AND METHOD OF ESTIMATING
THE AMOUNT OF SILAGE IN A PARTLY EMPTIED SILO *

Height of Silo in Feet	Approximate Capacity in Tons of Silo Having Diameter of					
	10 Feet	12 Feet	14 Feet	16 Feet	18 Feet	20 Feet
16	17	24	33	43	55	65
20	23	33	45	58	75	90
24	30	42	58	75	97	120
28	37	53	72	94	120	150
32	45	64	87	115	145	180
36	53	75	102	135	170	210
40	61	86	117	155	195	240
44	.....	97	132	175	220	270
48	.....	.....	147	195	245	300
52	.....	.....	.....	215	270	330

* Ill. Agr. Exp. Sta., Cir. 463.

To calculate the approximate weight of the silage remaining in a partially emptied silo, first find from the figures in the above table the approximate weight of the silage put into the silo. Then find the capacity of the silo for that part which

has been emptied and subtract this from the first figure. The difference is an approximation of the amount of silage remaining in the silo. For example, a silo 14 by 44 feet was filled to a height of 36 feet, 12 feet of silage remaining in the silo. The table shows that 102 tons of silage were put into the silo. The part emptied is equivalent to a silo 14 by 24 feet, which has a capacity of 58 tons. The difference between 102 and 58 is 44 tons, the amount of silage remaining.

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COMMUNITY STUDIES

Visit several farms and obtain information regarding the kinds of crops used for hay and the practices employed in making hay. Also visit a number of farms having silos. Make the visits at the time the silos are being filled and later when the silage from the same silos is being fed.

1. What crops are used for hay? Farmers' reasons for using these particular crops?
2. Describe the practices followed in making hay on the different farms, noting (a) the stage of development of the crop when harvested; (b) how soon after cutting raking is done; (c) whether windrows are turned; (d) methods of storage; (e) kinds of machinery used; (f) quality of hay made.
3. From your classroom study and your observations on these farms, do you think improvement might be made in (a) the kinds of crops grown for hay; (b) the methods used in harvesting and storing? Write criticisms of the methods used at each of the farms visited, listing (a) the good practices; (b) the poor practices, or practices that might be improved.
4. What is the construction of the silo?
5. What care is given the silo to keep it in good repair?
6. Is any special care given the silo just before filling?
7. What precautions are taken to make the doors fit tightly?
8. At what stage of development is corn cut for silage?
9. Describe the stage of development or condition of legume or grass crops, or other crops, harvested for silage.
10. Are any of these crops allowed to wilt in the field before ensiling, and if so, for how long a time?
11. What kind of field equipment is used in harvesting the silage crop?
12. How many men are employed?
13. How far is it from the field to the silo?
14. How many loads or tons of crop are ensiled daily?
15. Could changes be made to speed up the work or increase the efficiency of operation without entailing additional labor or equipment?

16. What is the length to which the crop is cut? Does the owner find the length of cut related to closeness of packing in the silo?
17. Is a preservative added during filling? If so, what kind is used and in what amounts? In what manner is the preservative added?
18. Is a flexible distributor pipe used in filling the silo?
19. Is the silage thoroughly tramped?
20. Are any precautions taken to prevent surface spoilage?
21. How soon after filling is feeding begun? How much silage, if any, must be discarded when the silo is first opened?
22. Is any moldy silage found in the silos you saw filled?
23. Can you account for the presence of mold on the basis of lack of sufficient moisture, insufficient tramping, or leaks through walls or around doors?
24. Does the grass or legume silage in any of the silos have a bright green color and good acid odor and taste? If not, can you account for its lack of high quality on the basis of insufficient preservative, poor packing, or other cause?
25. Does the owner find that the cattle eat legume or grass silage as well or better than corn silage?

CHAPTER XI

CARING FOR AND MARKETING DAIRY PRODUCTS FROM THE FARM

Remarkable progress has been made during the past twenty-five years by manufacturers, milk distributors, and transportation agencies in the handling of milk and cream. During the same period less effort has been expended in the improvement of these products on the farm. However, within the past few years the advent of cooperative marketing associations together with a general demand for a better product has, for the most part, improved the methods of production and the handling of dairy products on the farm.

The manufacturer, in spite of modern methods and improved machinery, can not greatly improve the quality of the product which he receives from the farmer. It is to the farmer or dairyman, therefore, that the consumer must look for any far-reaching future improvement. The milk from healthy, normal cows, properly nourished, does not differ greatly in germ content. The difference, therefore, between good and bad milk is largely due to the care and handling of the product. The two common dairy products marketed from the farm are milk and cream. Since they are produced by two different types of dairymen and marketed in different ways to different markets, their care will be considered separately.

Operations:

1. Caring for milk on the farm.
2. Caring for cream on the farm.
3. Marketing milk from the farm.

4. Marketing cream from the farm.
5. Marketing dairy products cooperatively.

1. CARING FOR MILK ON THE FARM

Milk is one of the most important of all food products. It is at the same time one of the easiest to contaminate. It furnishes an ideal medium for the growth of germs. Every producer of milk, therefore, should feel a moral obligation to exercise care



FIG. 89. AN INSANITARY DAIRY BARN

Poorly kept and unsightly premises outside buildings often bespeak insanitary conditions within. The manure heaps piled against the barn just outside the cow stable suffer great deterioration through the leaching of their fertility elements by the rain water's dropping from the eaves. Manure heaps are also the chief breeding places for flies. The barn lacks adequate lighting. Most city ordinances prohibit the sale of milk produced in barns such as this.

in the handling of his product and to keep it free from germs, especially disease germs. He should keep only healthy cows in his herd and they should be cared for by clean attendants who are free from all trace of disease.

In the handling of milk, the following procedure should be observed:

Procedure:

- A. Carefully wash all utensils.
- B. Sterilize utensils.

- C. Clean udder and flanks of cow.
- D. Milk into partially covered pails.
- E. Milk with dry hands.
- F. Strain milk through cotton or gauze.
- G. Cool milk quickly.
- H. Keep milk cool and deliver as quickly as possible.

A. Carefully wash all utensils. Wash utensils in clean, warm water to which has been added some good washing powder. Wash thoroughly until no trace of milk or dirt is left



FIG. 90. A BARN CONSTRUCTED TO FACILITATE CLEANING

Barns of masonry construction and having concrete floors can easily be kept clean. The tight ceiling prevents the sifting of dirt from the mow above and meets sanitary inspection. The numerous windows provide ample light, and during the winter months the ventilators insure the removal of foul air which might contaminate the milk.

in any of the creases or dents in the utensils. Be sure to wash all the utensils that come in contact with the milk, including cans, pails, strainers, dippers, stirring rods, and sampling tubes. Rinse thoroughly in clean, hot, preferably boiling, water.

B. Sterilize utensils. Clean utensils can be readily and easily sterilized with steam when it is available. Put utensils into a sterilizer and turn on live steam under several pounds pressure, leaving it turned on for ten to fifteen minutes. Cans

may be effectively steamed over a steam jet if the sterilizer is too small to accommodate them. Turn a large volume of steam through the jet into the mouth of the inverted can and allow to remain one minute. Steam the can lid also. Invert the can on a rack and allow to dry before replacing lid.

To sterilize utensils when steam is not available, put one-half to one gallon of a disinfecting solution into a can. Wash the can and all utensils which come in contact with the milk thoroughly with this solution, so that it covers every portion of the interior surface of the utensils. Disinfectants of the chlorine group are useful for this purpose and should be used according to the directions of the manufacturer. Drain utensils and allow them to dry. Recent investigations at the University of Illinois indicate that this method of sterilizing utensils is both cheap and effective.

In case it is not possible to sterilize with steam or by means of chemicals as indicated above, it is advisable to rinse utensils with freshly pumped well water just before they are to be used. This rinsing will tend to remove mechanically a great many germs and thereby reduce the resulting contamination of the milk.

C. Clean udder and flanks of cow. When the udders or flanks of cows have been soiled, remove the loose material with a curry comb or brush and wash with a damp cloth. This will prevent dirt and other material from dropping into the pail during the milking process, and will tend to insure the minimum of sediment.

D. Milk into partially covered pails. The value of the covered pail is inversely proportional to the cleanness of the cow. In other words, when the cow is clean the covered pail is not so necessary as when she is not so carefully groomed. The use of the covered pail, however, even with a clean cow, is a safeguard and reduces the opportunity for dirt to get into the milk. Figure 91 shows reduction in bacteria due to the use of a covered pail.

E. Milk with dry hands. Occasionally an individual imagines it is easier to milk after moistening the hands. Such a practice is decidedly insanitary and should not be tolerated.

F. Strain milk through cotton or gauze. Even though extreme care is exercised in the milking process, some sediment is almost sure to get into the milk. Always strain the milk through a cotton pad or a pad of similar material. Do not permit milk to pour directly on to a cotton strainer pad or the cotton may be torn and the sediment released into the milk.

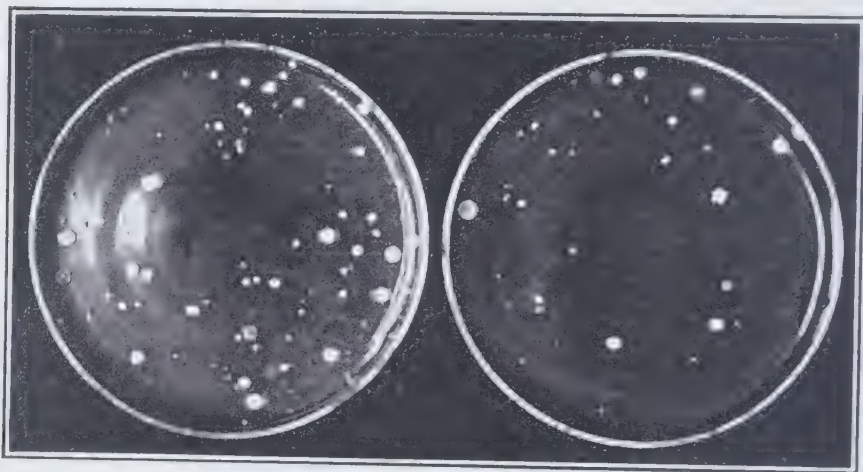


FIG. 91. A TEST OF THE VALUE OF THE CLOSED-TOP PAIL FOR MILKING

This illustration shows colonies of bacteria grown from milk obtained from a fairly clean cow, milked into a common open-top pail (left), and into a pail with a partly closed top (right). The number of bacteria was reduced nearly three-fourths by the use of the partly closed pail. This demonstration was conducted at Purdue University.

Cover the strainer in order to keep out flies and dirt while milk is not actually being poured into it.

G. Cool milk quickly. It is extremely important that milk be cooled as quickly as possible after milking. Plate 8 illustrates clearly the effect which cooling has on milk. Normal milk has a natural resistance to the growth of bacteria for some time after it is drawn from the cow. The effectiveness of this resistance is greatly increased if the milk is cooled quickly and held at the reduced temperature.

Figure 92 illustrates one method of cooling milk on the farm. The cans of milk are placed in the tank of water immediately after milking. The warm milk in each can is then cooled by stirring until the temperature is approximately the same as that of the water in the tank. To keep the milk as cold as possible, it is highly desirable that the water be kept flowing through the tank. This can be accomplished either by the use of flowing spring water if a spring is available, or by

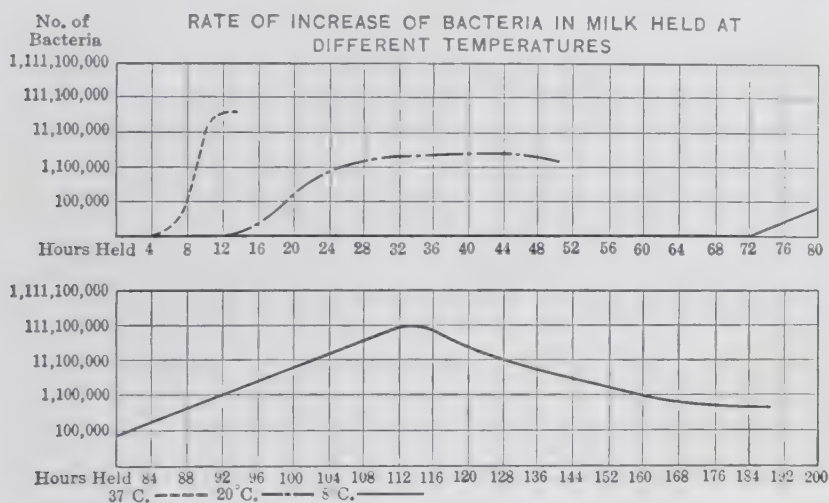


PLATE 8. KEEPING MILK COLD AIDS IN ITS PRESERVATION

The chart shows that milk held at a temperature of 37° C. for twelve hours contained as many bacteria as milk held at 8° C. for four days.

pumping well water. In the latter case it is usually advisable to allow the water to flow through the cooling tank to the stock tank.

An elaborate cooling tank is not necessary. Where not more than two or three cans of milk are to be cooled, a large barrel cut in half or a small wooden tank will suffice if cool water is kept flowing through it.

Some recent experiments at the Geneva Station in New York show that cooling milk in a tank is made very much more efficient and that stirring of milk during the cooling process is

unnecessary if the cooling tank is well insulated. A tank similar to the one shown in Fig. 92 if insulated with three to four inches of cork and provided with a two-inch cork board cover would be considered satisfactory and could be made at relatively small additional cost.

A quicker method of cooling milk on the farm is by using a surface cooler. In this method, cold running water or a mix-

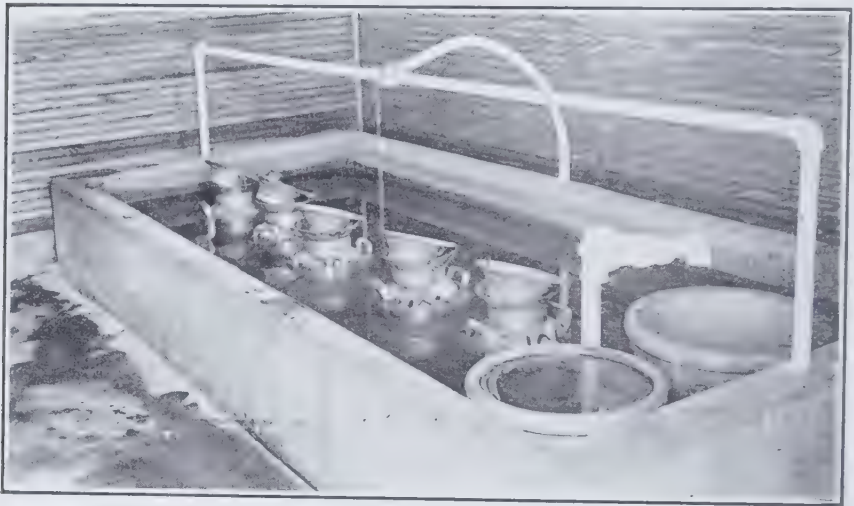


FIG. 92. A COOLING TANK FOR MILK

The water reaches nearly to the neck of the cans. Partly filled cans may be fastened to the horizontal rail above to keep them from tipping. Cooling tanks are also used in winter to keep milk from freezing. Note at the end of the tank the earthenware jars holding disinfectant solution in which milking-machine tubes and teat cups are kept between milkings. This tank could be improved by insulation and the addition of a cover.

ture of water and ice is put inside the cooler and the milk flows in a thin film over the outside, cooling quickly. The milk so cooled is then placed in cans in a tank similar to the one described above and held there until delivered. Table XXXII shows the relative efficiency of different cooling mediums for cooling milk in cans.

It is to be observed that cool air is a very poor conductor of heat and therefore a poor cooling medium. Water, on the

other hand, is a much better conductor and more efficient as a cooling agent.

Too much importance can not be attached to the cooling of milk. It is almost equal in importance to the sterilization of utensils in the production of milk of low germ content.

H. Keep milk cool and deliver as quickly as possible. Not only is it important to cool milk quickly and to a fairly low

TABLE XXXII

EFFECT OF VARIOUS COOLING MEDIUMS UPON THE RAPIDITY OF COOLING MILK IN CANS

Medium	Temp. Cooling Medium ° F.	Temp. Milk ° F.	Temp. 1 Hr. ° F.	Temp. 2 Hrs. ° F.	Temp. 24 Hrs. ° F.
Air (milk stirred).....	50	92	87.0	81	58
Air (milk not stirred)....	50	92	91.5	86	
Running water (milk stirred).....	54	92	62	57.5	56
Running water (not stirred).....	54	92	72	64	
Ice water (milk stirred)...	43	92	54	46	44
Ice water (not stirred)....	43	92	66	58	

temperature, 50° to 60° F., but it is necessary that milk be held at that temperature until delivered. Delivery, then, should be made as quickly as possible. If it could be made after each milking the highest-quality product would be insured but the added expense would probably be prohibitive. Milk drawn in the evening should be sent to the factory not later than the following morning.

2. CARING FOR CREAM ON THE FARM

The great bulk of cream is produced in small herds, usually of less than ten cows. As in practically all such cases the dairy

is a side line bringing in only a small part of the farm income, its management is made secondary to other farm operations. Under such conditions the product is not likely to be marketed in such first-class condition as when dairying is the main issue. In caring for cream on the farm, it is essential that the following procedure be followed:

Procedure:

- A. Clean and sterilize separator.
- B. Assemble separator and prepare for use.
- C. Adjust cream screw.
- D. Separate warm milk.
- E. Cool cream.
- F. Do not mix warm with cool cream.
- G. Market cream frequently.

A. Clean and sterilize separator. Pay special attention to procedures A and B in the preceding section on caring for milk, for they apply equally well to cream production. Wash the separator carefully in warm water to which washing powder has been added. If a disc machine is being used, wash each disc separately until no trace of milk or sediment remains. Using the same solution, wash the receiving tank and other parts. Sterilize by using steam or disinfecting solution referred to under B above. Rinse the machine thoroughly in hot water (almost boiling) and allow to dry.

B. Assemble separator and prepare for use. Just before milking time, assemble the machine carefully and be sure that all oil cups are filled with the kind of oil recommended by the separator company. If the weather is cold, run warm water through the machine before starting to separate the milk. Start the machine slowly and allow it to reach the proper speed before turning the milk into the bowl. Be sure that the separator is running at a uniform and proper speed. Test the skim milk by the Babcock method for efficiency of separation.

C. Adjust cream screw. For convenience and economy in marketing, cream should contain 40 to 45 per cent butter-

fat. If cream of a lower percentage is separated, the additional bulk adds to the transportation costs. If cream of a higher percentage is separated, some of the butterfat may be left in the skim milk.

To change the percentage of fat of the cream, it is necessary to adjust the cream screw. Turning the screw inward increases the percentage of fat in the cream; turning it outward

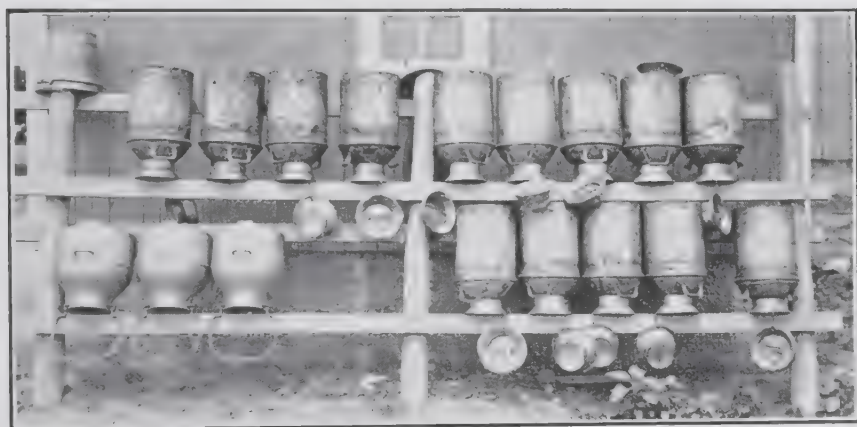


FIG. 93. GIVING CANS AND PAILS A SUN BATH

Experiments have shown that utensils are the primary source of contamination in milk. Rapid drying, obtained by inverting cans and pails on outside racks immediately after washing, is an effective way of reducing the germ content of milk. Bacteria do not multiply rapidly in the absence of moisture, and direct sunlight is very effective in destroying them. The principal criticism is that the cans are badly dented. Such dents roughen the interior of the cans, making them more difficult to wash and sterilize.

lowers the percentage of fat. Even though the position of the cream screw remains the same, the cream test will vary.

D. Separate warm milk. A cream separator will operate more satisfactorily and efficiently if milk is separated at the temperature at which it comes from the cow. When cold milk is separated, some of the fat is usually retained in the skim milk and there is difficulty in obtaining the correct percentage of fat in the cream. It is usually inadvisable to separate milk at a temperature below 70° F.

E. Cool cream. After separation is complete, run warm water through the separator until the milk and cream are removed. Cool cream as quickly as possible by placing the can in a tub or tank of cold water and stirring. Keep cool until delivered.

F. Do not mix warm with cool cream. When the quantity of cream separated at any one time is small, it may be necessary to mix it with other and older cream before marketing. Before doing this, be sure that the new cream has been cooled approximately to the temperature of the older cream. By observing this practice a better product is assured.

G. Market cream frequently. There is a tendency, principally because cream production is a side line, to market cream at infrequent intervals when it suits the convenience of the farmer. This practice results many times in an inferior product. The more frequent marketing of cream, if generally practiced, would improve the quality of creamery butter and in the long run would react toward a higher price to the farmer for his cream.

3. MARKETING MILK FROM THE FARM

Farmers and dairymen are beginning to display a special interest in the marketing of dairy products. Since the success of the dairy enterprise depends to no small degree upon the disposal of its products, the marketing problem must always continue to demand the attention of the producer. The marketing of milk presents a more pressing problem than the marketing of cream, because the receipts from the sale of milk in most cases are the chief income from the farm. By far the majority of the milk produced is marketed through the general or open market to milk dealers, cheese factories, and condenseries. A relatively small amount is marketed by individual dairymen through a special market.

Ways of marketing milk:

- A. The general market.
- B. Special markets.
 - (1) Select wholesale.
 - (2) Retail.

A. The general market. The general market is an open market. Competition is almost unlimited and the price is regulated very largely by the supply of milk. The margin of profit to the dairyman is so small that his success in the business must depend upon efficient methods of production. Generally speaking, there is a market for all he cares to produce and he can extend or reduce his business as he sees fit.

B. Special markets. Near towns and cities there are always a number of individual dairymen who desire to retail their own product. They are interested in exercising special care in the production of their milk and are able to obtain a higher price than that which prevails in the community. In such cases the milk is usually sold in bulk to restaurants, hotels, confectioners, etc.

Other dairymen are willing to invest in additional equipment and bottle and distribute their own milk. Such a method of disposing of milk increases the investment very materially, as well as the labor and other costs of production and marketing. When the business is properly managed, the increased selling price of the product more than equalizes the costs, and the profits from the enterprise are larger than they otherwise would be. However, the demands upon the time and energy of the dairyman are much greater when milk is marketed in this way, and a higher type of dairyman is required to make the business a success than if the milk is disposed of in the general market.

Certified milk is the best grade of milk sold and commands the highest price on the market. The demand for such a product is not large and is confined mostly to the larger cities.

The expenses incident to the production of milk of this quality are high, and only a small number of select dairies would make a success of this type of market.

4. MARKETING CREAM FROM THE FARM

Most of the cream produced on our farms ultimately finds its way to the creamery or centralizer and is there made into butter. The greater part of such cream is sold as sour cream, though an increasingly large percentage is being sold as sweet cream¹ at a slightly higher price. A relatively small percentage is marketed as sweet cream for special purposes.

Ways of marketing cream:

A. Sour cream.

B. Sweet cream.

A. Sour cream. Cream sours as a result of the multiplication and activity of the lactic acid bacteria (generally *Bacterium lactis acidi*). When the culture of such bacteria is pure, the cream has a desirable flavor and produces a high quality of butter. There are other organisms, however, which are often found in cream and which injure the quality. Sour cream is marketed in all conditions and stages. Because of this fact, some creamery operators have attempted to grade cream and pay a higher price for the better grades. In fairness to both the farmer and the creamery operator, this should be done. If it were the common practice, dairymen generally would pay more attention to the quality of their product with the result that they would receive a better price and the quality of cream and butter in general would be greatly improved.

B. Sweet cream. Cream that is marketed sweet for butter making is used for the making of a special grade of butter and

¹ Sweet cream, as the name indicates, is marketed while still sweet or at least has a low percentage of acidity; it is more desirable for most purposes and commands a higher price.

returns a somewhat higher price than sour cream. Much of the sweet cream sold is used in the making of ice cream, in restaurants, hotels, etc. In such cases, also, the cream brings a higher price than if marketed sour. Such a special market, if it exists throughout the year, is satisfactory to the dairyman and leaves him his skim milk on the farm for livestock feeding.

5. MARKETING DAIRY PRODUCTS COOPERATIVELY

In this country, as in almost every other country, there is a growing interest in the cooperative marketing of dairy products. Such a system of marketing can be made extremely useful if based upon the proper principles. It is a fundamental principle that the agency which can render a given service in the most satisfactory manner and at the lowest cost will be the one selected, in the long run, to render that service. Cooperative marketing, as well as every other system of marketing, is subject to this general law; and for this reason those who desire to substitute a cooperative system for the one now in vogue should strive to improve the methods of marketing, establish definite grades and standards for products, increase the efficiency of transportation and distribution—in short, perform the marketing service better than it is now performed, or can be performed, by private agencies. When a system of cooperative marketing of dairy products is established in accordance with such standards it is likely that marketing in this way will become a more common practice.

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CHAPTER XII

REARING THE DAIRY CALF

There is no more important detail in the care and management of a dairy herd than the rearing of the calves. Well-grown, vigorous animals are usually those that have had excellent care from birth. Undernourished, stunted calves often, although not always, may be grown out into large animals by careful feeding; but calves that are thrifty, vigorous, and large when six months of age are much more resistant to disease and have a much better opportunity to develop into large, useful animals. Undersized calves may be due to false ideas of economy on the part of the feeder, as well as to a lack of knowledge of the principles and practices of successful calf raising.

Operations:

1. Considering the essential qualities of a good ration for dairy calves.
2. Caring for the calf at birth.
3. Teaching the calf to drink.
4. Feeding the milk often.
5. Feeding the milk warm.
6. Substituting skim milk for whole milk.
7. Raising calves on a limited amount of whole milk.
8. Feeding dried or powdered skim milk.
9. Feeding buttermilk and whey.
10. Feeding proprietary and home-mixed calf meals.
11. Keeping utensils clean.
12. Feeding grain mixtures.
13. Feeding hay or other dry roughage.
14. Feeding silage.

15. Feeding after discontinuing milk.
16. Pasturing calves.
17. Insuring a supply of minerals and vitamins.
18. Preventing growth of horns.
19. Marking calves for identification.
20. Providing bedding for calves.

1. CONSIDERING THE ESSENTIAL QUALITIES OF A GOOD RATION FOR DAIRY CALVES

The young calf needs a ration which not only furnishes all the nutrients necessary for maintenance and growth, but which is strikingly different from rations of mature animals in that it must be highly digestible. Milk contains chiefly proteins, sugar, butterfat, minerals, vitamins, and water, all of which are very readily digested and utilized by the young calf. Milk proteins are distinguished from most proteins of vegetable feeds in having all the amino acids, or building stones, which are needed for growth. Milk is, in fact, the only feed so far known that will satisfactorily nourish the calf from birth until it is several weeks old.

The digestive tract of a calf but a few days old can not digest rough feeds such as hay, oat hulls, corn stover, etc., which are high in fiber content. Investigations show that calves can digest very little pure starch until they are a week or more of age; their ability to digest starch increases up to the time they are four weeks old. It is important, therefore, that calves be fed milk in the amounts required until they are able to utilize feeds containing starch and fiber. Even after that time, milk should be fed to supply those essentials, such as a complete assortment of the amino acids, vitamins, and minerals, in which the other part of the ration may be deficient.

2. CARING FOR THE CALF AT BIRTH

Too often, the calf is left to shift for itself at the most critical period of its life. Lack of care during the first few

days usually means the loss of a large number of calves that might easily have been saved.

Procedure:

- A. Provide good quarters to receive the calf.
- B. Keep the calf warm.
- C. Assist the calf in nursing, if necessary.
- D. Make sure the calf receives colostrum milk.
- E. Disinfect the calf's navel.

Equipment:

Fork, shovel, broom, air-slaked lime or disinfectant solution, tincture of iodine solution, cup, sprinkling can, blanket or gunny sacks.

A. Provide good quarters to receive the calf. Watch the breeding records of the herd in order to know when calves may



FIG. 94. A PROMISING FUTURE FOR THE HERD

Raising the heifer calves from the best cows is the surest method of building up a high-producing herd. These youngsters are the offspring of excellent sires as well as excellent dams.

be expected to be born. Prepare a box stall a day or two in advance. Clean the stall thoroughly, removing all bedding and scraping and sweeping down the sides of the stall if manure or filth has gathered on them. If any calves having

white scours have been in the stall previously, clean the stall thoroughly and then disinfect it with a strong solution of lye water (8 ounces of lye to 5 gallons of water). In case the stall has a dirt floor, or if the weather is so cold that the stall would not dry, a liberal amount of air-slaked lime may be used instead.

After the stall has dried, place a large amount of clean, dry bedding in it. Keep the stall well bedded and as dry as possible. Avoid drafts so far as possible, although fresh air is desirable.

Calves born in the summer time do not require such close attention as those born during cold weather. Calves born at pasture during warm weather usually require less attention than those born in the barn, although if the weather is rainy or cold there is danger of infection or chilling.

B. Keep the calf warm. Be sure that the calf is dry and warm. If it shivers, cover it with a blanket or a number of gunny sacks. Provide an abundance of dry bedding.

C. Assist the calf in nursing, if necessary. In case the calf is unable to stand and nurse its mother, give it some assistance. Sometimes two persons are necessary if the calf is very weak. Make certain that the calf receives some of the first milk, or colostrum. It should have an opportunity to nurse four or five times during the first day.

D. Make sure the calf receives colostrum milk. The first milk secreted by the cow after calving, called colostrum, is beneficial to the calf in helping its digestive tract to function properly and also in transferring to the calf large amounts of vitamins A and D. Possibly also minute substances called antibodies are transferred from the mother in the same way. The antibodies are thought to protect the calf for a short time against infectious diseases. Colostrum milk contains five to fifteen times the amount of vitamin A and several times the amount of vitamin D contained in normal milk.

The great value of vitamin A in the development of the young calf is shown by recent experimental work in which it

was found that whole milk can be replaced by skim milk at an early age provided the skim milk is supplemented by large amounts of vitamin A (given as cod-liver oil) and some grains to furnish additional energy.

Colostrum also has a third function, that of acting as a laxative to free the digestive tract of fecal material.

Therefore, make sure that the calf receives some of the first milk secreted by its mother after calving. If for any reason this is not possible, supply the calf with the milk of some other cow which has just calved.

E. Disinfect the calf's navel. As soon as possible after the calf has been given the first attention necessary, disinfect the navel. Paint the raw, exposed part of the navel cord with tincture of iodine, using a small brush or piece of cheesecloth. If iodine is not available, use a 5 to 10 per cent solution of a coal tar disinfectant, placing this in a cup and holding the cup up under the calf so that the navel cord is immersed in the solution. Repeat the treatment daily until the cord becomes dry.

The disinfection of the navel is very essential as it helps to prevent disease germs from entering the body of the calf at that point.

3. TEACHING THE CALF TO DRINK

This is an operation that requires considerable patience, as some calves are slow in learning to take milk from a pail.

Procedure:

- A. Separate calf from its mother.
- B. Provide milk from the calf's mother.
- C. Use patience in teaching calf.

A. Separate calf from its mother. When the calf is one or two days of age, place it in a pen where it will not have access to any cow. Calves that are very weak may have to be left

with their mothers for three days or even more, but strong, vigorous calves may usually be separated from their mothers at twenty-four to thirty-six hours of age. If they remain with their mothers longer than this, there is danger of their obtaining so much milk that indigestion results. Also they are more readily taught to drink if separated at an early age.

B. Provide milk from the calf's mother. Use milk from the mother of the calf for feeding during the first few days, unless the milk is not suitable on account of its being thick, stringy, or too rich. Milk that is rich in fat, such as Jersey and Guernsey milk, sometimes causes digestive disturbances. If this occurs, dilute the rich milk with skim milk, using one part of skim milk to two parts of whole milk. In the absence of skim milk, use warm water in the same proportions. After the calf is five to seven days old, milk from the herd may be substituted for the mother's milk.

C. Use patience in teaching calf. Pour about a quart of the mother's milk into a clean pail used for feeding calves, keeping account of the amount. Back the calf into a corner, and bring its nose into contact with the milk. This is best accomplished by allowing the calf to suck the fingers of the feeder so that the head may be guided into the pail. After the calf has obtained a few mouthfuls of milk, remove the fingers, although whenever the calf lifts its head out of the pail it is necessary to repeat the procedure. When the calf has consumed the amount of milk first offered, pour in the rest of the milk that is to be given at that feeding.

Use as much patience as possible, for the calf may choke if its nose be forced into the milk. It is sometimes necessary to omit a feeding before the calf can be taught to drink.

4. FEEDING THE MILK OFTEN

In feeding the calf, it must be borne in mind that the digestive system of a very young animal can not assimilate a large amount of food at one time.

Procedure:

- A. Determine amount of milk to be fed.
- B. Save milk for several feedings.

A. Determine amount of milk to be fed. A good rule to be followed in determining the amount of milk to be fed is that 1 pound of milk should be fed daily for each 10 pounds of live weight of the calf, with a maximum amount of 15 to 18 pounds daily. When scales for weighing the calves are not available, the data in Table XII may be used as a guide to the normal weight at various ages. Plan to feed the calf three or four times daily during the first seven days, at as nearly equal intervals as possible, as there is less danger of indigestion when the daily allowance of milk is fed in small quantities at short intervals.

B. Save milk for several feedings. At milking time feed the calf fresh mother's milk or mixed milk from the herd. At the same time save out enough milk for the other feedings during the day.

5. FEEDING THE MILK WARM

It is important that the milk given to a calf be in good condition and at the proper temperature.

Procedure:

- A. Feed milk immediately after it is drawn.
- B. At other times warm milk to body temperature.
- C. Keep milk in good condition.

Equipment:

Clean pails, cooling tank, hot water or steam, thermometer.

A. Feed milk immediately after it is drawn. Feed the very young calf at once after securing the milk from its mother, when the milk will be at about body temperature. Milk cools rapidly in winter and if fed when cold may cause indigestion,

especially if the milk is cold at one feeding and warm at another.

B. At other times, warm milk to body temperature. Be careful to warm the milk that has been saved for the feedings between milkings to about body temperature (100° F.). To warm the milk, place it in an 8- or 10-quart pail. Set this pail in a large pail containing 3 to 4 quarts of hot water. If steam is available, turn the steam into the water surrounding the pail of milk. If neither steam nor hot water is available, place the pail containing the milk on a stove, stirring the milk constantly until it reaches the desired temperature. Use a thermometer, preferably of the floating type, if available. It is not advisable to heat the milk by turning steam or hot water into it, as this dilutes the milk too much.

C. Keep milk in good condition. Place the milk that has been saved for the other feedings in a can, and set in a cooling tank. This is necessary in summer to prevent souring, and in winter to prevent freezing. Keep the can covered to prevent flies and dust from getting into the milk. It is best not to feed sour milk to very young calves, although this often may be done successfully with calves five to six months of age. Try to have the milk that is to be fed to very young calves in the best possible condition.

6. SUBSTITUTING SKIM MILK FOR WHOLE MILK

In some of the best purebred dairy herds, it is the practice to feed whole milk to calves until they are six months or more of age. Whole milk is, of course, the best feed for calves, as it induces rapid gains, and the calves that receive it keep in a healthy, sleek condition, being at the same time less subject to digestive troubles. In most dairy herds, however, this method of raising calves is too expensive, and skim milk, alone or with calf meals, is used to take the place of the whole milk, and concentrates are fed to supply energy equivalent to that in the butterfat. Another plan is to feed the calves

on a limited amount of whole milk until they are two and one-half months of age, at the same time inducing them to eat as much grain and hay as possible.

Procedure:

- A. Secure supply of skim milk.
- B. Make substitution gradually.
- C. Stanchion calves at feeding time.
- D. Remove foam from milk before feeding.
- E. Continue skim-milk feeding as long as practical.

A. Secure supply of skim milk. If a cream separator forms part of the farm equipment, separate some milk at each milking and feed the skim milk fresh to the calves. Separate the milk as soon as possible after it is drawn from the cows, so that it will not be necessary to heat it. Should the milk become cold before being fed, heat it to about body temperature. In cold weather, warm the bowl of the separator by running two or three quarts of hot water through it, before beginning to separate the cream.

When a cream separator can not be used on the farm, skim milk may sometimes be purchased from a creamery. Such milk should be thoroughly pasteurized at the creamery in order to prevent the transmission of disease germs. In case it has not been pasteurized, it can be made safe for feeding by heating to the boiling point, or by holding at a temperature of 150° F. for thirty minutes.

B. Make substitution gradually. Begin substitution of skim milk for whole milk when calves are about three weeks old. Calves that are below normal in size or vigor should receive whole milk somewhat longer. Make the substitution a gradual one. For example, suppose 5 pounds of whole milk is being fed each calf at each feeding time. The first day skim milk is used, mix 1 pound of skim milk with 4 pounds of whole milk at a feeding. The second day use the same proportions. The third and fourth days, use 2 pounds of

skim milk to 3 pounds of whole milk, and so on until substitution is complete.

TABLE XXXIII

MILK-FEEDING SCHEDULE FOR RAISING CALVES ON WHOLE MILK
FOLLOWED BY SKIM MILK

(Concentrates and Hay to Be Fed in Addition)

Age of Calf, Days	Larger Breeds (Holstein, Brown Swiss, Ayrshire)				Smaller Breeds (Jersey, Guernsey)			
	Amount of milk				Amount of milk			
	Whole, per day, pounds	Skim, per day, pounds	Total per period		Whole, per day, pounds	Skim, per day, pounds	Total for period	
			Whole, pounds	Skim, pounds			Whole, pounds	Skim, pounds
1	With mother	.....	.....	.....	With mother	.....	.....	.....
2	8	.....	8	.....	6	.....	6	.....
3- 20	10	.....	180	.....	7	.....	126	.....
21	9	2	9	2	6	2	6	2
22	8	3	8	3	6	2	6	2
23	7	4	7	4	5	3	5	3
24	6	5	6	5	5	3	5	3
25	5	6	5	6	4	4	4	4
26	4	7	4	7	4	4	4	4
27	3	8	3	8	3	5	3	5
28	2	10	2	10	3	6	3	6
29	1	11	1	11	2	7	2	7
30	0	12	0	12	2	7	2	7
31	0	12	0	12	1	8	1	8
32- 35	0	12	0	48	0	9	0	36
36- 48	0	13	0	182	0	10	0	140
49- 63	0	14	0	196	0	11	0	154
64-182	0	15	0	1785	0	12	0	1428
Totals.	.....	.....	233	2291	.....	.....	173	1809

The age at which skim-milk feeding should begin depends somewhat upon the amount of concentrates and hay being consumed. The concentrates take the place of the butterfat of the whole milk; therefore, if the calves are not eating concentrates in liberal amounts, the beginning of skim-milk feeding must be delayed until they do eat them.

C. Stanchion calves at feeding time. If more than one calf is kept in a pen, provide individual stanchions and mangers. Fasten calves in stanchions before feeding them milk, and keep them stanchioned until after they have been fed some concentrates. This plan helps to prevent the calves from spilling the milk and also from sucking each other.

D. Remove foam from milk before feeding. Whenever there is a large amount of foam on the skim milk, it should be removed by drawing a paddle or small board across the surface of the milk, or else held back with a piece of cheesecloth while the milk is slowly poured into the pails for feeding. Foam is objectionable in that it causes calves to take too much air into their stomachs, resulting in bloating.

E. Continue skim milk feeding as long as practical. Continue to feed skim milk until the calves are six months of age, or better still, one year of age, if possible. In some cases, however, the milk is too valuable to be used for feeding purposes except during the first three to four months when milk is essential in giving the calves a good start. Consult Table XXXIII for the amounts of skim milk to be fed daily.

7. RAISING CALVES ON A LIMITED AMOUNT OF WHOLE MILK

The following directions apply to conditions where skim milk is not available and whole milk must be used sparingly.

Procedure:

- A. Feed calves liberally at start.
- B. Encourage calves to eat other feeds.
- C. Follow definite schedule in feeding milk.

A. Feed calves liberally at start. Feed liberal amounts of whole milk to the calves until they are four weeks of age, but do not feed more than they can use to advantage. About 1 pound of milk per day for each 10 pounds of live weight is a good rule to follow.

B. Encourage calves to eat other feeds. During this period use every effort to encourage the calves to eat grain mixtures and legume hay in large amounts. The more of these they eat, the less will be the total amount of milk required. Keep a

TABLE XXXIV

MILK-FEEDING SCHEDULE FOR RAISING CALVES ON MINIMUM AMOUNTS OF WHOLE MILK WITH GRAIN MIXTURE AND HAY AS THE ONLY SUPPLEMENTS

Age of Calf, Days	Larger Breeds (Holsteins, Brown Swiss, Ayrshires)		Smaller Breeds (Jerseys and Guernseys)	
	Amount of Milk		Amount of Milk	
	Daily, Pounds	Total for Period, Pounds	Daily, Pounds	Total for Period, Pounds
1	With mother	.....	With mother	.....
2	6	6	4	4
3-21	10	190	6	114
22-35	8	112	7	98
36-42	6	42	6	42
43-49	4	28	5	35
50-56	2	14	5	35
57-60	2	8	4	16
61-70	.....	.....	4	40
71-78	.....	.....	2	16
Totals....	.....	400	.....	400

supply of concentrates of different kinds, such as wheat bran, ground oats, linseed oil meal and ground corn separately, if possible, or else mixed—where the calves have constant access to them. Provide fine-stemmed, leafy clover, alfalfa, or other legume hay, and put a fresh supply in the rack whenever the

finer parts have been eaten. The success of this plan of raising calves on a small amount of milk depends upon getting them to eat large amounts of the other feeds.

Extensive calf-feeding trials at the University of Illinois have shown that calves must have milk until they are at least sixty days of age. Even after sixty days, some calves in the experiment greatly benefited by feeding milk for a longer period. In no case was it found possible to discon-

TABLE XXXV

POUNDS OF WHOLE MILK TO BE GIVEN AT EACH FEEDING

Date	Calf No. 1	Calf No. 2	Calf No. 3
January 12.....	5	4	2
January 13.....	5	4	1
January 14.....	4	3	1
January 15.....	4	3	1
January 16.....	4	3	1
January 17.....	4	3	1
January 18.....	4	3	1
January 19.....	4	3	1
January 20.....	4	3	0
January 21.....	3	2	0

tinue milk feeding at sixty days of age unless the calf had been accustomed to eating liberal amounts of hay and grain mixture. These trials, which were for the purpose of determining the minimum amounts of milk required for rearing calves successfully, showed that calves that were fed a total of about 400 pounds of milk up to the time they were two and one-half months old, and at the same time were self-fed on grain mixture and legume hay, made excellent growth. Smaller amounts of milk were insufficient.

C. Follow definite schedule in feeding milk. Consult the feeding schedules in Table XXXIII and arrange in advance

a complete milk-feeding schedule for each calf, such as the one shown in part above.

Post this chart near the balance where the milk is weighed at feeding time.

If a calf has digestive troubles, fails to eat enough of the other feeds to make good gains, or for any reason appears unthrifty, increase the amount of milk for a time or do not reduce it as fast as the schedule calls for, as seems best.

8. FEEDING DRIED OR POWDERED SKIM MILK

Dried or powdered skim milk can sometimes be secured at such a price that it can be fed economically as a substitute for the fresh whole milk or skim milk.

Procedure:

- A. Prepare definite schedule for each calf.
- B. Prepare milk for feeding.
- C. Feed in same manner as separator milk.
- D. Feed dried milk mixed with concentrates.

Equipment:

Clean pails, milk can, dried skim milk, scales, hot water, stirring rod, feeding charts.

A. Prepare definite schedule for each calf. Consult the directions for feeding skim milk and prepare a daily feeding chart for each calf, setting down opposite each date the amount of skim milk to be given at each feeding. The same directions as to the amounts of skim milk to be fed apply to the dried milk after it has been prepared for feeding.

B. Prepare milk for feeding. Calculate from the feeding charts that have been prepared the amount of the skim milk required for all the calves at each feeding. Weigh out one-tenth this amount of dried milk into a pail. If there are any lumps in the powder, rub them through a fine sieve. Add an equal weight of slightly warm water and stir the milk for a

few minutes to dissolve as much of it as possible. Now pour into a milk can or other sufficiently large container, and add eight times as much warm water by weight as the dried milk weighed out. This will bring the weight of the mixture up to ten times the amount of the dried milk, which is similar to the concentration of separator skim milk. Stir the mixture thoroughly. The water should be warm enough to bring the final mixture to about body heat.

C. Feed in same manner as separator milk. Feed the skim milk prepared from the dried milk in the same manner and in the same amounts as ordinary separator skim milk.

D. Feed dried milk mixed with concentrates. Vigorous calves, after reaching the age of six to eight weeks, may be reared successfully on mixtures of dried skim milk and farm grains reinforced with protein, mineral, and vitamin supplements. Such mixtures are sometimes termed "calf starters."

A mixture recommended by the State College of Washington consists of powdered skim milk, 25 pounds; ground barley, 20 pounds; ground oats, 20 pounds; wheat bran, 15 pounds; blood meal, 10 pounds; linseed meal, 7 pounds; bone meal, 2 pounds; salt, 1 pound. A mixture that has given good results at Cornell University is the following: ground yellow corn, 32.25 pounds; rolled oats (hulls sifted out), 28 pounds; wheat bran, 10 pounds; linseed meal, 5 pounds; white fish meal, 3 pounds; dried skim milk, 20 pounds; salt, 0.5 pound; bone meal, 0.5 pound; ground limestone, 0.5 pound; reinforced cod-liver oil, 0.25 pound. These mixtures should be fed at the rate of 2 to 4 pounds per head daily and the feeding may be continued to six months of age. Care should be taken to supply the calves with ample amounts of fresh drinking water (warmed in winter) and also high-quality legume hay.

Claims are made that feeding "calf starters" in pellet form increases feed consumption and rate of gain, but experimental tests have given conflicting results and have not conclusively demonstrated the desirability of this additional expense of preparation.

9. FEEDING BUTTERMILK AND WHEY

Undiluted buttermilk fresh from the churn is a good substitute for whole milk or for skim milk when fed to calves six to eight weeks of age. It is similar to skim milk in composition except that it contains slightly more butterfat and also contains some lactic acid. The acid induces a laxative condition in young calves and for this reason care must be taken to substitute the buttermilk for the other milk gradually and also not to feed it to young calves. Dried buttermilk may be reconstituted to the fresh basis by mixing one pound of dried buttermilk with nine pounds of warm water. Evaporated, or semi-solid, buttermilk requires the addition of 3 pounds of water to each pound of buttermilk. Prepared and fed in the manner described, fresh buttermilk and the reconstituted buttermilks have about the same feeding value for dairy calves as skim milk.

Whey is a by-product of cheesemaking. Practically all the fat and a large portion of the protein of whole milk go into cheese, leaving in the whey all the sugar (about 5 pounds in 100 pounds of whey) and about one-fourth of the protein (about 0.8 pound in 100 pounds of whey). Because of the low protein content of the whey, a grain mixture is needed that is much higher in protein content than a grain mixture suitable as a supplement to skim milk. When fed with a suitable supplement, whey has a feeding value about one-half that of skim milk.

Both buttermilk and whey should be carefully pasteurized or sterilized at the factory, and care should be taken to keep them in clean vats free from decomposing material.

10. FEEDING PROPRIETARY AND HOME-MIXED CALF MEALS

It is often stated that milk is too expensive to feed to calves except in very limited amounts, and attempts are made to raise calves on so-called "milk substitutes." Investigations

have shown that there are no complete substitutes for milk for very young calves.

Trials at the Illinois Station indicated that commercial calf meals, as then commonly manufactured, could not be used successfully as complete substitutes for milk any earlier than could good grain mixtures fed with legume hay. Much better growth can be obtained if commercial calf meals are used merely as supplements to milk rather than as substitutes for it. These meals have the advantage, however, of being easily made into the form of a gruel and are usually somewhat better suited for young calves than ordinary grain mixtures, although the relative costs must be considered.

The following directions have been formulated to provide a reliable guide for the feeding of calf meals.

Procedure:

- A. Obtain supply of calf meal.
- B. Prepare feeding schedule for each calf.
- C. Feed only amounts required.
- D. Use care in feeding and mixing meal.
- E. In case of indigestion, feed milk only.
- F. Continue milk feeding to two months of age.

A. Obtain supply of calf meal. The proprietary or ready-mixed calf meals may be purchased on the market. Directions for feeding usually accompany each package. Usually these directions call for the use of too little milk to grow strong, vigorous calves. The suggestions given in the following sections may help to overcome this difficulty and yet not make the cost of feeding too great.

Home-mixed calf meals have also been used with some success as substitutes for part of the skim milk usually fed. A mixture recommended for this purpose by Cornell University consists of the following: yellow corn meal, 25 pounds; oat flour or ground oats, sifted, 15 pounds; malted barley, 10 pounds; red dog flour, 22 pounds; linseed meal, 15 pounds;

soluble blood flour, 10 pounds; precipitated bone meal, 1 pound; precipitated calcium carbonate, 1 pound; salt, 1 pound. The mixtures of dried skim milk mentioned in Section 8 above may also be fed in gruel form if they are finely ground.

Use only good-quality materials, grind finely, and store in a dry place.

B. Prepare feeding schedule for each calf. It is essential that each calf be fed carefully measured amounts of feed, since irregular amounts may cause indigestion. Therefore, as soon as it is decided to raise a calf, rather than to sell it for veal, make out a complete feeding schedule, such as the one shown in Table XXXVI. This schedule should be carefully followed unless it is found that either more or less should be fed to give best results, or unless indigestion occurs, as discussed below.

The amounts of milk for the first seven weeks as shown in Table XXXVI are the same as those shown in Table XXXIII, which is planned for calves of average size for their respective breeds. A more exact schedule could be made out by weighing each calf each week, feeding the milk at the rate of 1 pound daily for each 10 pounds of live weight. One pound of the calf-meal gruel may be considered equivalent to 1 pound of skim milk.

C. Feed only amounts required. Follow the directions carefully so that the calves will receive enough nourishment and yet not suffer from indigestion due to overfeeding. The amounts of calf meal required are about as follows:

From twenty-one days to thirty-five days of age, 1 tablespoonful (about 1 ounce) of calf meal at each of two feedings daily, the dry meal being placed in the milk.

From thirty-six to seventy days of age the amount of calf meal may be increased and the skim milk decreased. During this period the meal should be first mixed with water to form a gruel, as described in the following section. Two ounces of calf meal when mixed with 16 ounces of water may replace 1 pound of skim milk.

After seventy days of age, 24 ounces of calf meal per head daily for the larger breeds, and 20 ounces for the smaller breeds, is sufficient. Somewhat larger amounts may safely be fed as the calves increase in size.

TABLE XXXVI

SAMPLE DAILY FEEDING SCHEDULE FOR RAISING CALVES ON MILK AND CALF MEAL

(One-half of the Amounts Shown to Be Given at Each Feeding)

Date	Age of Calf, Days	Calf No. 1 (Holstein)			Calf No. 2 (Jersey)		
		Whole Milk, Pounds	Skim Milk, Pounds	Calf Meal, Table-spoonfuls	Whole Milk, Pounds	Skim Milk, Pounds	Calf Meal, Table-spoonfuls
Jan. 11.....	20	10	0	0	7	0	0
Jan. 12.....	21	9	2	2	6	2	2
Jan. 13.....	22	8	3	2	6	2	2
Jan. 14.....	23	7	4	2	5	3	2
Jan. 15.....	24	6	5	2	5	3	2
Jan. 16.....	25	5	6	2	4	4	2
Jan. 17.....	26	4	7	2	4	4	2
Jan. 18.....	27	3	8	2	3	5	2
Jan. 19.....	28	2	10	2	3	6	2
Jan. 20.....	29	1	11	2	2	7	2
Jan. 21.....	30	0	12	2	2	7	2
Jan. 22.....	31	.....	12	2	1	8	2
Jan. 23-26.....	32-35	.....	12	2	0	9	2
				Ounces			Ounces
Jan. 27-Feb. 2...	36-42	.....	10	6	.....	8	4
Feb. 3-9.....	43-49	.....	8	10	.....	7	6
Feb. 10-16.....	50-56	.....	6	14	.....	6	8
Feb. 17-23.....	57-63	.....	4	18	.....	4	12
Feb. 24-Mar. 2...	64-70	.....	2	22	.....	2	16
Mar. 3-June 21..	71-182	.....	0	24	.....	0	20

Calf meal may be fed dry as part of the concentrate mixture, such feeding being begun as soon as the calves will eat concentrates. A suitable mixture may be made by combining ground corn, ground oats, wheat bran, and calf meal in equal parts by weight.

D. Use care in mixing and feeding meal. As directed above, the dry calf meal may be placed in the milk until the calf reaches the age of five weeks. Since the amount of milk is decreased and the calf meal increased beginning with the sixth week, the calf meal should be mixed with water before being added to the milk. A small amount of cold water is first added and the mixture stirred until all lumps disappear. Then warm water is added until the final mixture consists of 1 pound of calf meal to 9 pounds of water and the temperature is



FIG. 95. SUNSHINE AND EXERCISE PROMOTE HEALTH IN GROWING CALVES

Growing calves are benefited by exposure to sunshine and by moderate amounts of exercise. Calves closely housed may not receive adequate amounts of vitamin D. Clean exercising yards are desirable.

that of the body. Care must be taken that the mixture is fresh, that is, not allowed to stand after mixing until it ferments, and that the pails are washed and scalded frequently. Heating the gruel to a temperature of 145° F. for thirty minutes and then cooling to body temperature before feeding has been recommended as a method of preventing digestive disorders. Experiments have shown that the feeding value of the mixture is not increased by cooking. The calf-meal gruel and milk mixture or calf-meal gruel alone should be fed at body temperature.

E. In case of indigestion, feed milk only. Indigestion quite frequently occurs when calves are fed too large amounts of calf meal, or when the gruel or milk is fed at varying temperatures or in irregular amounts. If such difficulty is experienced, feed the calf milk only for a few days until the trouble disappears. Gradually return to the regular schedule.

F. Continue milk feeding to two months of age. Milk is often fed in smaller quantities and calf meal in larger quantities than here recommended, but calf raising seldom proves successful unless milk feeding is continued until the calf is at least two months of age.

11. KEEPING UTENSILS CLEAN

While cleanliness is necessary in all feeding operations, it is especially important in the feeding of young animals, which are always more susceptible to infection than older ones.

Procedure:

- A. Use separate pails for feeding calves.
- B. Wash and sterilize pails and other utensils.

A. Use separate pails for feeding calves. Keep a separate set of pails for use in feeding the calves. Ten-quart galvanized iron pails with iron handles are suitable for this purpose, as they are light in weight and can be readily nested.

B. Wash and sterilize pails and other utensils. Each day the cream separator, all pails, dippers, cans, etc., should be washed, steamed or scalded with boiling water, drained, and placed so that the sun can shine into them, as explained in Chapter XI. It is very essential that the utensils used in feeding the calves be kept clean, for dirty pails are very often the cause of indigestion and other calf ailments, and may carry disease from one calf to another.

12. FEEDING GRAIN MIXTURES

If properly chosen and prepared, grain mixtures may be fed quite freely to young calves.

Procedure:

A. Provide suitable grain mixture.

B. Begin feeding at early age.

A. Provide suitable grain mixture. Protein feeds such as blood meal and flaxseed meal are sometimes the first concentrates fed to calves. Such high-protein feeds are not the best supplements to milk for the nutrition of the calf. Milk is in itself a high-protein feed, skim milk having a higher proportion of protein than whole milk, so that any feed used with it should be low in protein and high in energy value.

Good concentrates for calves are corn, oats, wheat bran, linseed meal, hominy feed, dried beet pulp, and wheat middlings. All except the linseed meal may be fed separately; or the feeds may be combined into mixtures like the following; ground corn, 2 parts; ground oats, 2 parts; wheat bran, 2 parts; linseed meal, 1 part. Another good mixture consists of ground corn, 1 part; ground oats, 5 parts; wheat bran, 3 parts; and linseed meal, 1 part.

Calves under three months of age usually prefer the ground feeds, but after three months of age whole grains may be fed. Cottonseed meal often proves poisonous to young calves and should not be fed.

B. Begin feeding at early age. Begin feeding grain mixtures as soon as the calves will eat them, which probably will be when they are seven to fifteen days of age. It is usually necessary to coax the calves in the beginning in order to get them accustomed to the feed. To do this, place a small handful of the grain mixture used, or ground oats, or ground corn, in the pail as the calf is finishing its milk, or offer a little in the hand immediately after feeding milk.

Provide large amounts of grain mixture so that the calves may grow rapidly. This is especially important if skim milk is fed at an early age. The grain mixture may be weighed or measured twice daily and placed in a box or manger to which the calf has access, or a constant supply may be kept before the calves.



FIG. 96. GIVING BOTH THE FUTURE DAIRYMAN AND THE FUTURE COW A GOOD START

There is nothing that will give a boy a greater interest in farm life than to permit him to raise a good animal for his very own.

The amount of grain mixture consumed by calves under the usual plan of feeding is about 2 pounds per head per day when the calves are two to three months old, and 3 to 4 pounds when they are six months old.

13. FEEDING HAY OR OTHER DRY ROUGHAGE

The principal roughage fed to calves should be good legume hay, such as clover or alfalfa.

Procedure:

- A. Provide fine-quality legume hay.
- B. Use other roughages only as supplement.

A. Provide fine-quality legume hay. Place some fine-stemmed, leafy legume hay, such as clover or alfalfa, in a rack so that the calves may have access to it from the time they are ten to fourteen days old. Calves often begin to nibble at the hay when very young, and learn to eat roughage readily. Replace the hay with a fresh supply every two or three days, or whenever the finer parts of the hay have been consumed. The part refused by the calves may be fed to the older animals in the herd.

B. Use other roughages only as supplement. Other roughages, such as non-legume hay, corn stover, etc., are suitable only as supplements to legume hay and not as the only roughages fed, if good results are to be expected. Such roughages may be fed in a separate rack, so that the calves have access to both legume and non-legume roughage at the same time. In the case of calves several months old, one feed of legume hay and one of non-legume roughage may be given daily.

14. FEEDING SILAGE

Certain precautions must be observed in feeding silage to calves. If fed too early or too freely it may prove harmful.

Procedure:

- A. Feed silage to calves over three months of age.
- B. Feed silage in limited amounts.
- C. Use only good silage.

A. Feed silage to calves over three months of age. When silage is available it may be fed to calves as soon as they will eat it, which is usually at three months or more. Silage is not an especially desirable feed for calves, but may prove eco-

nomical and stimulating to the appetite in the absence of more suitable roughages, such as good legume hay. It is not necessary, therefore, to feed silage if the ration already contains satisfactory feeds.

B. Feed silage in limited amounts. Calves should be given small amounts of silage daily, as it proves too laxative if fed liberally. Feed 2 to 3 pounds daily to calves three to four months of age, and increase these amounts about 1 pound per day for each month of the calf's age.

C. Use only good silage. Use every precaution to insure the quality of the silage fed the calves. Moldy or damaged silage may lead to indigestion or poisoning.

15. FEEDING AFTER DISCONTINUING MILK

The period during which calves are most often neglected is soon after milk feeding is discontinued. This is especially true if the calves are turned out to pasture and not given any regular daily feeding or attention to bring them under the observation of the caretaker.

Procedure:

A. Watch condition of calves carefully.

B. Feed liberally.

A. Watch condition of calves carefully. Examine the calves several times a week, noting their general thriftiness. It is not necessary that they remain fat, but they should keep growing, the hair should be sleek and the hides soft, and there should be no evidences of indigestion. As calves that are growing rapidly often present a gaunt appearance, it is sometimes difficult to tell whether they are gaining in weight or not. A simple method of checking this accurately is by weighing the calves weekly or by measuring the height at the withers.

B. Feed liberally. Feed the calves liberally from the time milk feeding is discontinued. Good legume hay and concentrates are among the best feeds, although good pasture is also desirable.

16. PASTURING CALVES

Calves should be turned into a separate pasture, watched carefully, and supplied with everything that they require.

Procedure:

- A. Use separate pasture for calves.
- B. Pasture calves only when six months or more of age.
- C. Watch condition of calves at pasture.
- D. Supply water, shade, and minerals.

A. Use separate pasture for calves. Provide a small paddock or separate pasture for calves, if possible. This is especially desirable in order to prevent injury by the older animals, to avoid nursing of cows in milk, and to prevent the calves from exciting the cows by running about among them.

B. Pasture calves only when six months or more of age. Do not attempt to have calves less than six months of age secure much of their feed from pasture. The annoyance of flies, exposure to the heat of the sun, and excessive exercise are disadvantages of pasture which more than offset the value of the small amount of feed gathered.

C. Watch condition of calves at pasture. Make sure that the calves are receiving sufficient feed to keep them growing rapidly. If the pasture alone is not adequate for this purpose, feed some supplements, as indicated above under Section 15.

B. Supply water, minerals, and shade. Give the calves access to a constant supply of fresh water and common salt. If the pasture consists of non-legume grass growing on an acid soil, it is well to give the calves some mineral supplement, such as steamed bone meal of feeding grade. Provide shade in very hot weather.

17. INSURING A SUPPLY OF MINERALS AND VITAMINS

Special care must be taken to provide dairy calves with adequate amounts of minerals and vitamins. As pointed out in Chapter VIII, the vitamins to which most attention must be given in the feeding of dairy cattle are vitamins A and D. Young calves fed only milk and not exposed to sunlight are likely to develop rickets. Older calves are also subject to this malady during the winter months, especially if there is a deficiency of calcium and phosphorus in the ration. Symptoms of rickets are swollen and stiff joints, an arched back, a craving for sticks and refuse, and a poor appetite. Calves fed skim milk and bleached, stemmy roughages may not have an adequate intake of vitamin A.

Calves at pasture in summer are protected against rickets by sunlight, but winter sunlight is so low in its antirachitic potency that protection from rickets during the winter months must come through proper feeding methods. Green, leafy, new-crop hay cured in sunlight furnishes protection from rickets and also provides large amounts of vitamin A. Calves should be encouraged at an early age to consume freely this kind of hay. In the absence of hay of this sort, protection from rickets can be provided by the use of a cod-liver oil concentrate, as suggested in Section 8 of this chapter, or by feeding daily in the milk a feed grade of cod-liver oil at the rate of 5 cc. (1 teaspoonful) for each 100 pounds of live weight of the calf.

Calcium is best provided by the use of legume hays, and phosphorus is supplied by grain mixtures that contain 20 to 25 per cent high-protein supplements.

18. PREVENTING GROWTH OF HORNS

The practice of dehorning cows in order to prevent them from injuring one another is considered very humane. A fight between horned cows frequently results in severe injury and

sometimes in death. It is much easier, and causes less suffering, to prevent the growth of the horns than to remove them after they are full-grown. Dehorning is not ordinarily practiced in show herds, since well-shaped and polished horns are considered an additional point of merit in the show ring.

Procedure:

- A. Watch for growth of horns on calves.
- B. Clip hair around horns.
- C. Apply vaseline to skin around horns.
- D. Apply caustic.

Equipment:

Scissors, vaseline or salve, caustic.

A. Watch for growth of horns on calves. The horns begin to form little prominences, or buttons, on the head when the calf is but a few days old. When these can be plainly felt, which occurs when the calf is about a week old, they should be treated to prevent further growth of the horns.

B. Clip hair around horns. Clip the hair closely around each of the horns, exposing a clean surface of the skin. Use sharp scissors for this purpose.

C. Apply vaseline to skin around horns. Apply some vaseline or other salve to the skin around the horn, but do not apply it to the skin covering the tip of the horn. The purpose of the vaseline is to prevent the caustic from spreading and injuring the skin.

D. Apply caustic. For this purpose use a stick of caustic (caustic soda or caustic potash, which can be secured at a drug store). Keep all except the tip of the stick carefully wrapped in paper to protect the hands. Have someone help hold the calf still. Moisten the tip of the stick of caustic slightly in water and rub firmly on the skin covering the tip of the horn. Rub until the skin becomes red and is about to bleed. Be

careful not to get so much water on the caustic that it runs down on other parts of the skin or into the eyes of the calf.

If the treatment is effective, a deep scab will form in two or three days. This will slowly heal, and in the course of a few weeks the scab will drop off and hair will return. If the first



FIG. 97. PREVENTING THE GROWTH OF HORNS ON A YOUNG CALF

Treating the horns of young calves with caustic potash, as shown in the illustration, is very effective in preventing the growth of the horns and causes less harm to the animal than removing the horns after they become full grown.

treatment is not effective, repeat after the fourth or fifth day, rubbing a little more vigorously.

19. MARKING CALVES FOR IDENTIFICATION

Some reliable system of marking animals for identification should be employed in every herd. The method described in this section has been found satisfactory for calves.

Procedure:

- A. Mark calves as soon as possible.
- B. Adopt permanent system of marking.

A. Mark calves as soon as possible. Before the calf is separated from its mother, that is, within a day or two after birth, place a strap bearing a numbered brass tag about the calf's neck. Enter the number, together with date of birth, weight, etc., in your record book. If the calf is other than a solid color, sketch the outlines of the color markings in the place provided in your herd book, and enter there, also, the appropriate data. The sketching should be done within a week or two after birth.

B. Adopt permanent system of marking. The neck straps with numbered tags are satisfactory until the calf is a year old, but there is always danger that the strap may become broken and lost. A more permanent system of marking, such as one of those described in Chapter XV, should be adopted, and all calves should be marked according to that system before they are more than one year of age.

20. PROVIDING BEDDING FOR CALVES

Provide ample amounts of bedding to keep calves dry. When calves lie on wet bedding in cold weather, they are likely to become chilled and to contract severe colds or pneumonia.

Clean, dry wheat or oat straw, or shredded corn stover, makes excellent bedding material for young calves. Shavings and sawdust are not good for bedding calves which receive milk only, since such calves may eat some of the bedding. Fatal results usually following the eating of shavings or sawdust.

Experiments carried out at the New Jersey Agricultural Experiment Station showed that the use of wire floors in calf pens resulted in a saving of two-thirds to three-fourths of the

amount of bedding required. The wire cloth used had a three-fourths inch mesh and was made from No. 11 wire, galvanized after weaving. The cloth was placed over wooden frames on which No. 9 wire had been stretched to support the wire cloth. A space of six inches between the frame and the cement floor

TABLE XXXVII

AMOUNT OF FEED CONSUMED BY DAIRY HEIFERS FROM BIRTH TO ONE YEAR OF AGE

(Results Expressed in Pounds per Head)

Feed	Lot I * 20 Holstein Heifers	Lot II † 29 Holstein Heifers	Lot IV ‡ 40 Jersey Heifers	Lot IV ‡ 20 Jersey Heifers
Whole milk.....	244	499	465	342
Skim milk.....	860	2786	2928	3165
Concentrates.....	1107	658	597	547
Hay.....	1067	768	709	857
Silage.....	1669	586	468	353
Corn stover.....	.....	28	40	.....
Pasture (days).....	.....	128	122	123

Live Weight and Gain in Weight

Weight at birth.....	92	82	56	.....
Weight at 1 year.....	532	564	472	.....
Average daily gain.....	1.2	1.3	1.1	.....

* Ill. Agr. Exp. Sta., Cir. 202. (Heifers given no pasture.)

† Ohio Agr. Exp. Sta., Bul. 289.

‡ U. S. Dept. Agr. Bul. 49.

of the pen permitted cleaning. The bedding placed over the wire cloth remained much drier than when used on a cement floor and it was thought that the calves remained freer from colds, scours, and pneumonia, and also made better gains than when housed in the usual manner.

GENERAL INFORMATION

Amounts of feed needed by dairy calves. (Questions often arise regarding the cost of raising a dairy heifer calf. The accompanying table shows the amounts of feed consumed by Holstein and Jersey heifers under carefully controlled conditions.)

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COMMUNITY STUDIES

Visit some of the dairy farms where calves are being raised and obtain information on the following points. If possible, make one visit during the winter and another visit to the same farm during the pasture season.

1. At what season of the year are most of the calves born?
2. Is any special provision made for receiving calves at birth in clean, dry box stalls?
3. Is the navel of each calf disinfected soon after birth?
4. How long are the calves permitted to remain in the stall with their mothers, or to nurse their mothers?
5. How are the calves taught to drink?
6. Is each calf fed its mother's milk, or is it given mixed milk from the herd?
7. How many times daily are the calves fed whole milk?
8. How much milk is given at each feeding?
9. How is the amount of milk to be fed determined?

10. Is milk weighed or measured at each feeding? How?
11. Is the milk warmed before feeding, and if so, how is it warmed?
12. Is a thermometer used to determine the correct temperature?
13. How is milk kept from freezing in winter and from souring in summer?
14. Are the horns of the young calves treated to stop their growth?
15. If so, how is this done?
16. If skim milk is fed, secure the following information:
 - (a) Is the milk separated at home by means of a hand or power cream separator?
 - (b) Is milk fed fresh from the separator without further warming?
 - (c) If skim milk is purchased, has it been pasteurized or otherwise treated to make it safe for feeding?
 - (d) At what age is skim milk substituted for whole milk?
 - (e) How rapidly is the substitution made?
 - (f) What rule is followed in determining the amount of skim milk to be fed?
 - (g) Are calves stanchioned at feeding time?
 - (h) Is foam removed from milk before feeding?
 - (i) If milk is heated before being fed, how is this done?
 - (j) How old are the calves when skim milk feeding is discontinued?
 - (k) How much do the calves weigh at the end of the skim-milk feeding period?
 - (l) What has been the daily gain in weight of each calf?
17. If a home-mixed calf meal is used, what are the substances used, and how is the meal mixed?
18. If either a home-mixed calf meal or a purchased calf meal is fed, make the following inquiries:
 - (a) How is the meal prepared for feeding?
 - (b) How old are the calves when meal is first fed?
 - (c) How is the amount to be fed determined?
 - (d) What amount of whole milk or skim milk is fed in addition to the calf meal?
 - (e) What is the age of the calves when milk feeding is discontinued?
 - (f) What is the age and weight of the calves when calf-meal feeding is discontinued?
 - (g) What is the rate of gain in weight per day?
 - (h) How does the cost per pound of gain in weight compare with the cost per pound of gain of calves on other farms, which have been fed skim milk?

19. At what age are calves first fed concentrates?
20. What concentrates are fed at first?
21. What concentrate or concentrate mixture is used when the calves are three months old? Six months?
22. At what rate are the concentrates fed?
23. Are the concentrates fed in a pail after feeding milk, or in a trough or manger?
24. Are concentrates fed individually to each calf or to several calves as a group?
25. At what age is roughage first fed?
26. What kinds of roughages are used?
27. Is roughage available at all times?
28. If silage is fed, at what age do the calves begin to eat it?
29. How much silage is fed to one calf daily?
30. How are the calves fed after milk feeding is discontinued?
31. Are the calves pastured before they are one year of age?
32. Is feed in addition to pasture provided?
33. Is shade provided?
34. Are the calves given access to salt or other minerals?
35. How are the calves marked for identification?
36. Are the pails and other utensils used in feeding the calves, the cream separator, etc., frequently washed and scalded?
37. If buttermilk or whey is fed, is it in good condition?
38. Are special precautions taken to insure an adequate supply of minerals and vitamins, and if so, what provisions are made?
39. In your opinion, on which farms were calves being raised with the most successful results and to what procedures do you attribute these good results? On the farms where the calves seemed to be in poorest condition, what procedures might be used to improve the practices being used?

CHAPTER XIII

FEEDING AND DEVELOPING DAIRY HEIFERS

The size and development attained by a dairy heifer before the birth of her first calf is very largely dependent upon the character of the feed and care she has received. Heifers are often neglected after they are old enough to live on feeds other than milk. While dairy cows continue to grow until they are four or five years of age, those that are undersized at their first calving may not reach normal size unless very liberally fed, for the production of milk tends to check the rate of growth. It is good practice, therefore, to feed heifers very liberally and give them the best of care in order that they may be at least normal in size by the time they are ready to produce milk.

1. FEEDING HEIFERS AFTER THE MILK PERIOD

Considerable care and thought should be given to the feeding of growing heifers, in order that all necessary elements, in correct proportions, may be present in their rations.

Procedure:

- A. Note condition of heifers frequently.
- B. Provide good pasture, if possible.
- C. Supply supplements to pasture when necessary.
- D. Furnish water, minerals, and shade.
- E. Give heifers good care during winter months.
- F. Feed liberally in winter.

A. Note condition of heifers frequently. Close attention must be given the heifers after milk feeding is discontinued, to see that they are consuming enough feed to keep them growing

rapidly. If heifers are changed abruptly from a milk and grain ration to pasture, they usually consume but little feed for a time and lose weight rapidly. It is a good plan, therefore, to see that they are accustomed to eating roughage before they are turned out to pasture. Examine the heifers frequently to see if they are troubled with lice, mange, ringworm, or other ailments. (See Chapter XVI for methods of treatment.) Once a month weigh or measure the heifers and determine rate of gain from previous measurements, or compare with normal measurements given in Table XII.



FIG. 98. GOOD PASTURE IS ONE OF THE BEST FEEDS FOR HEIFERS

Good pastures provide large amounts of protein, minerals, and carotene. Exposure to the sun furnishes vitamin D. This picture, taken on May 8, shows the luxuriant growth made by an experimental plot of winter rye. The wire cage at the left protects an area to be harvested by hand for the determination of yields. Compare this picture with Fig. 99.

B. Provide good pasture, if possible. Good pasture is usually an economical source of feed supply for growing heifers. In addition, it furnishes the necessary growth factors which are often lacking under winter feeding conditions. Provide legume pasture if possible, since legumes furnish protein, which heifers require in large amounts for growth. The legumes also furnish much larger quantities of the minerals necessary for growth than do the non-legumes.

C. Supply supplements to pasture when necessary. As early spring pasture grass is very high in water content, a pound of fresh grass at that season provides relatively little

nourishment. Hence it is best to continue the feeding of a grain mixture to young heifers for two or three weeks after they are first turned on spring pasture. During late spring and early summer good pasture alone usually provides plenty of feed for growing heifers; but as soon as the grass becomes dry and the pastures somewhat bare, additional feed must be supplied. Yearling heifers may be fed the same kind of supplements, consisting of grain mixtures, soiling crops, silage, etc., that are being used for the cows in milk (Chapters VIII



FIG. 99. BLUEGRASS PASTURES FURNISH EXCELLENT FEED FOR HEIFERS FOR A SHORT PERIOD

Bluegrass pastures provide palatable forage which is high in nutritive value. Bluegrass is persistent in maintaining a pasture sod with the expenditure of little labor. However, the yields are usually small except for a period of a few weeks in spring and early summer. Compare with Fig. 98, a scene a few rods away, photographed on the same day.

and IX). Heifers about a year of age or less, however, can not be expected to consume enough soiling crops or silage to meet their requirements. For such heifers, provide a concentrate mixture, fed at the rate of $\frac{1}{4}$ to $\frac{1}{2}$ pound daily per 100 pounds live weight, and, in addition, 2 to 4 pounds of legume hay.

D. Furnish water, minerals, and shade. Supply the heifers with fresh, clean, well water. Water in stagnant ponds may contain disease germs. Permit the heifers to secure all the common salt they desire; and if the pasture and other rough-

age consist chiefly of non-legumes, give them access to mineral supplements, as recommended for dairy cows in Chapters VIII and IX.

Provide shade for the heifers in very hot weather.

E. Give heifers good care during winter months. It is a decided mistake to attempt to make growing dairy heifers "rough it" through the winter. Do not expect them to secure their principal feeds during the winter months from stalk fields



FIG. 100. HEIFERS MUST BE LIBERALLY FED IN ORDER TO MAKE NORMAL GROWTH

Supplying large amounts of legume hay is one of the best procedures for insuring rapid growth in heifers. Feeding legume hay in an outdoor rack is also an excellent method of supplementing short pastures.

or straw stacks. Protect the heifers from severe weather by housing them in a comfortable, well-ventilated barn. Good housing means a decided saving in the amount of feed necessary for maintenance.

F. Feed liberally in winter. When the supply permits, feed the heifers largely on legume hay, with some grain mixture in addition. Often the coarser portions of clover or alfalfa hay, which are refused by the cows, may be fed to advantage to the heifers. Corn stover and non-legume hay may be used in

liberal amounts for heifers, but should be supplemented, if possible, by one feed daily of legume hay. Provide all the roughage the heifers will consume, in order to develop their digestive capacity.

Feed silage, if available, to the extent of about 2 pounds

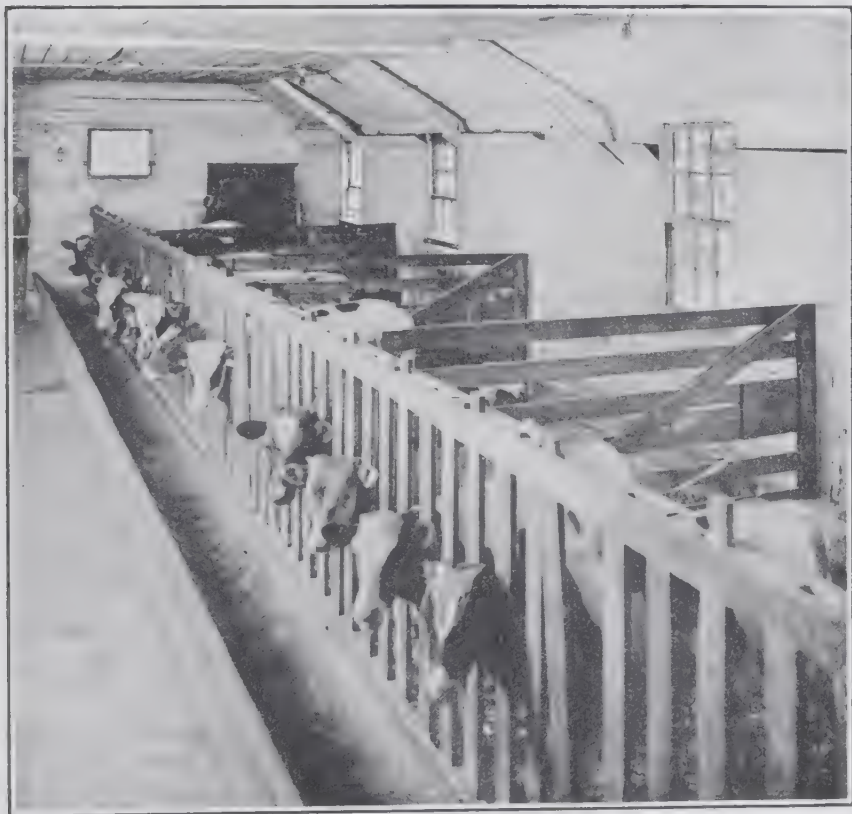


FIG. 101. BARN FOR YOUNG STOCK WITH INEXPENSIVE EQUIPMENT
The swinging gates readily may be used to form box stalls.

daily per 100 pounds live weight. No harm will result, however, from feeding as much as the heifers will eat, if it is of good quality.

Feed grain mixture in addition to the roughage, in order to keep the heifers growing rapidly. Provide grain mixture in accordance with the following suggestions:

(1) When legume hay is being consumed at the rate of 1 pound daily and corn silage at the rate of 2 pounds daily per 100 pounds live weight, or in larger amounts, feed $1\frac{1}{2}$ pound of grain mixture daily per 100 pounds live weight to heifers weighing 500 pounds or less (about one year of age or less). Under the same conditions, feed $1\frac{1}{3}$ pound grain mixture daily per 100 pounds live weight to heifers weighing over 500



FIG. 102. SWEET-CLOVER PASTURE FURNISHES AN ABUNDANCE OF FEED FOR GROWING HEIFERS

Sweet-clover pasture provides large yields of forage, but it is not so palatable as some other pasture crops. After becoming accustomed to it, heifers consume it readily and thrive on it.

pounds (over one year of age). The grain mixture may consist of one-fourth to one-third protein concentrates and the balance ground grains, such as corn, oats, or barley.

(2) When non-legume roughages only (such as timothy, redtop or prairie hay, corn stover, corn silage, etc.) are being fed liberally or in amounts similar to those mentioned above, feed grain mixtures in the same amounts as given above; but then the concentrate mixture must contain two-thirds to three-

fourths protein concentrates. If less roughage than the quantities mentioned under paragraph (1) is being consumed, increase the supply of grain mixture.

At all times the judgment of the feeder must be exercised in deciding upon the amounts of grain mixture to be fed. No hard and fast rules can be laid down. The quality of the feeds, the warmth of the quarters, the amount of outdoor exposure, and the climate, all play a part in affecting the amounts of feeds needed.

Breed is also a factor to be given consideration. Leading Jersey breeders think it best to feed Jersey heifers very liberally on roughage by providing excellent pasture as the main or only feed during the summer months and a plentiful supply of good-quality roughage in winter, adding only enough grain mixture to insure normal growth. The heifers are not permitted to become fat until shortly before calving. Two or three months before calving, liberal feeding on grain mixture is begun in order to have the heifers in an excellent state of flesh at the beginning of the lactation period. This helps to insure higher milk yields and a higher percentage of fat in the milk.

GENERAL INFORMATION

1. FACTORS AFFECTING GROWTH AND DEVELOPMENT OF DAIRY HEIFERS

Various factors have an influence upon the size attained by the dairy cow at maturity. Although heredity plays an important part, most of these factors can be controlled by feeding and management.

A. Breed of dairy heifers. The limits of the size of the calf at birth and the size of the mature individual are determined largely by characteristics inherited from the parents, and these are peculiar to the breed to which the animal belongs. Thus, the average Holstein female is larger at birth

than the average Jersey female and, as a rule, attains a larger size at maturity. No known plan of feeding will cause the Jersey calf to develop into as large an animal as the Holstein.

The Jersey heifer reaches her full size of skeleton at about four years of age, while the Holstein continues to grow until she is nearly five years old. The Jersey female attains her maximum weight at about six years of age, while the Holstein reaches this stage when six or seven years old.

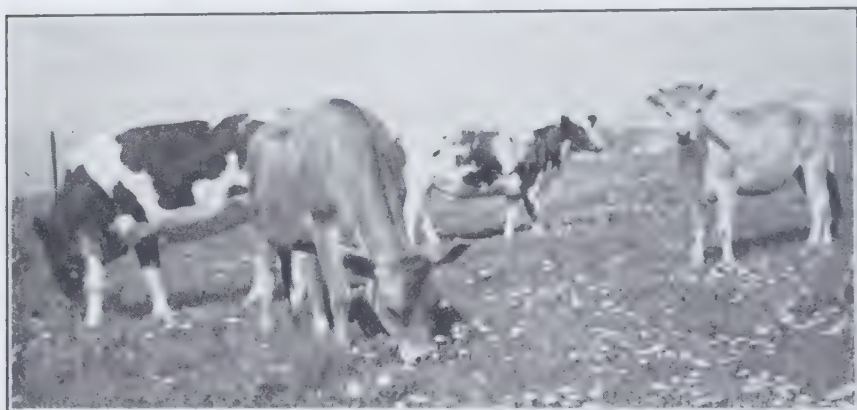


FIG. 103. GOOD PASTURE FURNISHES ALL THE FEED NEEDED BY GROWING HEIFERS

Fresh green pastures supply growing heifers with all the nutrients needed, provided the amount of forage is ample. Much labor is thereby saved as compared with barn feeding. This bluegrass pasture is difficult to keep free from weeds and usually becomes dormant in midsummer. When green and growing, however, the quality of the forage is unusually high.

B. Size of calf at birth. There seems to be little, if any, direct relation between the size at birth of calves of the same breed, and their size at maturity, provided they are given a good opportunity to develop.

C. Effect of pregnancy on growth. Careful records of the rate of growth of heifers during the time they are carrying calves indicate that pregnancy has no material effect upon their rate of growth. Some feed in addition to that required for growth, however, must be supplied for the development and maintenance of the fetus.

D. Effect of lactation on growth. After a good dairy cow gives birth to a calf, she possesses a strong stimulus to produce milk. The nutrients received in her feed are directed toward the production of milk so far as possible, and often if they are not sufficient, she draws upon her own body tissues. Naturally, under such conditions, growth is seriously retarded. It is only when young cows are liberally fed that they can continue to grow normally after they have begun to produce milk.

E. Effect of feed supply. It has been pointed out that the possibilities for growth in an animal are largely determined by



FIG. 104. ONLY THE COARSE STUBS REMAIN

Yearling heifers grazed this field of tall Sudan grass so closely that only the coarse stubs remained. Beyond the fence in the adjoining plot, Sudan grass made a second growth more than fence-high after having been grazed down close to the ground. Sudan grass makes excellent midsummer pasture for heifers.

the size of the breed. Whether an animal reaches the maximum size for the breed, however, depends mainly upon the character and amount of the feed supply.

Protein in liberal amounts is essential in the ration, since the lean flesh of the animal consists chiefly of protein and water. The feed must furnish material to restore the wear and tear of these tissues, as well as to construct new tissue. The carbohydrates (consisting of starches, sugars, fiber, etc.) and the fats furnish energy for the maintenance of the body from day to day, and also furnish materials entering into the building of new tissues.

Minerals and vitamins are of especial significance in growth. Lime and phosphorus are needed in large amounts. Phosphorus is found in nearly all cereal grains and their mill by-products, and is present in particularly large amounts in cottonseed meal and legume seeds. Lime, however, is found in large amounts in but few of the feeds used for growing heifers. These feeds are the legume hays and skim milk, and these are by far the best sources of lime now known. In the absence of legume hay in the ration, mineral supplements should be supplied, as discussed in connection with pasture, although even then growth is usually not so rapid as when legumes are fed.

Vitamins promote growth and protect against disease. Fresh, green, growing feeds, legume hays, and fresh milk are the best-known sources of vitamins for growing cattle. Sunlight in moderation is desirable. Because of the beneficial effects of sunshine, it is poor dairy practice to keep growing heifers continuously in dark quarters.

REFERENCES

U.S.D.A. Leaflet 14, Raising the Dairy Heifer.

U.S.D.A. Farmers' Bul. 1723, Feeding, Care and Management of Young Dairy Stock.

Note: See also the references given in Chapters VIII and IX.

COMMUNITY STUDIES

When making visits to some of the better dairy herds of the community to observe methods of calf raising, learn the methods used in feeding and developing the dairy heifers.

1. What are heifers fed after milk feeding is discontinued?
2. Are the heifers given close attention and good care?
3. Are the heifers of about normal size for their age?
4. Are heifers weighed or measured in order to determine whether they are making normal growth?
5. With reference to summer feeding—
 - (a) What kinds of pasture crops are used?
 - (b) Does the pasture furnish a large amount of feed?

- (c) Are supplements to pasture offered, and if so, what kinds and in what amounts?
- (d) How are salt, or other minerals, and shade provided?
- (e) How do the heifers secure drinking water while at pasture?

6. With reference to winter feeding:

- (a) How are the heifers housed during the winter months?
- (b) Are the heifers liberally fed in winter, or do they "rough it"?
- (c) Are the heifers lean and gaunt, do they carry a medium amount of flesh, or are they fat and blocky?
- (d) Do the heifers appear to be thrifty and to be growing rapidly?
- (e) What kinds of roughages are fed?
- (f) Where and how often are the roughages fed?
- (g) Is an effort made to cause the heifers to eat as much roughage as possible?
- (h) Are the heifers fed concentrates?
- (i) What are the kinds and amounts of concentrates fed?

CHAPTER XIV

FEEDING AND MANAGING THE DAIRY BULL

The feeding and care of the dairy bull are usually given much less attention than they deserve. In but few herds is the feeding of the bull given as much thought as the feeding of one of the best cows; yet very much of the success of the herd depends upon the treatment of the herd bull. Since bulls of the dairy breeds are expected to grow to be about 50 per cent heavier than the mature cows, they must receive plenty of feed of the proper kind. The loss of the breeding powers of bulls is doubtless more often due to a lack of proper care than to old age.

Operations:

1. Feeding the bull calf.
2. Caring for the young bull.
3. Ringing the bull.
4. Dehorning the bull.
5. Leading the bull.
6. Controlling the use of the bull.
7. Feeding the mature bull.
8. Housing and exercising the bull.
9. Caring for vicious bulls.
10. Retaining a good bull.

1. FEEDING THE BULL CALF

It is common practice, in dairy herds containing grade cows, to dispose of the male calves for veal when three to ten weeks of age. In herds in which the calves are purebred, however, the male calves, as well as the females, are raised. The direc-

tions here given for the raising of the bull calf are intended to apply particularly to the calf of good breeding being raised to head a dairy herd.

Procedure:

- A. Feed bull calf in same manner as heifer calves.
- B. Feed bull calf very liberally.



FIG. 105. EXERCISING YARDS FOR BULLS

Bulls must have plenty of exercise if they are to remain in good breeding condition. The open shed provides shade and shelter in summer.

A. Feed bull calf in same manner as heifer calves. The bull calf should be fed in much the same way as the heifer calves until he is six months of age. Follow the directions for

feeding outlined in Chapter XII; but, if at all possible, continue the feeding of skim milk until the bull calf is at least six months, or better, ten to twelve months, of age. If it is not possible to feed skim milk, extend the period of whole-milk feeding longer than is usually done with the heifers, and supply choice legume hay. If the bull calf shows a greater capacity for feed and growth than the heifer calves, increase the allowance of milk and concentrates somewhat over the amounts suggested, but feed less roughage in proportion to the other feeds than is done with the heifers.

B. Feed bull calf very liberally. Feed the bull calf so that he will continue to grow very rapidly, particularly after he is six months old. The milk allowance may be as much as 20 pounds daily. There is usually no advantage in feeding more than this. Use especial care in seeing that the bull calf gets plenty of feed when on pasture. When the pasture grass is very watery in the spring and when it becomes dry or scanty in late summer and fall, feed some of the concentrate mixture used for the milking herd. This may be fed in amounts of $1\frac{1}{2}$ to $2\frac{1}{3}$ pound daily per 100 pounds live weight. Continue to use concentrates as a supplement to pasture for the bull calf, rather than soiling crops or silage. The object should be to promote rapid growth and large size of frame in the bull calf, without enlarging the middle of the animal to such an extent as with heifers.

Provide choice legume hay as the chief roughage, since skim milk and legume hay are the two feeds par excellence for supplying high-quality proteins, vitamins, and minerals for growth.

2. CARING FOR THE YOUNG BULL

In addition to liberal feeding, the bull calf requires exercise, proper housing, and special care.

Procedure:

- A. Separate the young bull from the heifer calves.
- B. Provide exercise and good quarters.

A. Separate the young bull from the heifer calves. When the bull calf reaches the age of five to six months, he should not have opportunity to mingle with heifers or cows that are not pregnant. Should all the cows or heifers in the herd be in calf, however, the bull calf under one year of age may be permitted to run in the pasture with the herd.

B. Provide exercise and good quarters. Keep the bull calf in good condition by plenty of exercise and good shelter. During the winter, provide a roomy, warm box stall, opening into a yard where the bull may be turned on pleasant days. The stall should be kept dry and clean and should have an abundance of light. In summer, the young bull may be kept in a separate lot or pastured with other bulls or with a herd of pregnant cows. Some shade during extremely hot weather is desirable.

3. RINGING THE BULL

As a matter of safety, a ring, by which the bull may be led, should be inserted in his nose. The ring should be placed in the nose when the bull is from nine to twelve months of age.

Procedure:

- A. Provide ring of non-rusting material.
- B. Tie bull securely.
- C. Make opening in nose by means of trocar.
- D. Pass ring through opening and fasten with screw.

Equipment:

Bull ring, trocar and cannula, file or sandpaper, halter.

A. Provide ring of non-rusting material. Select a ring of non-rusting material, such as copper, gun metal, or brass. The ring for the young bull should be of light or medium weight. When the bull becomes well grown, this ring should be replaced by one of heavier weight and larger size. It is well to keep an extra ring on hand in case of breakage or loss of the one in use.

B. Tie bull securely. Before attempting to place the ring in the bull's nose, fasten the bull securely in a strong stanchion, making sure that he can not lunge forward upon the persons inserting the ring. It is best to tie a large animal by means of a strong halter as well as to place him in a stanchion.

C. Make opening in nose by means of trocar. The trocar and cannula, illustrated in Fig. 106, is the best instrument for making the opening through the cartilage that forms the dividing wall between the nostrils. The trocar, cannula, and

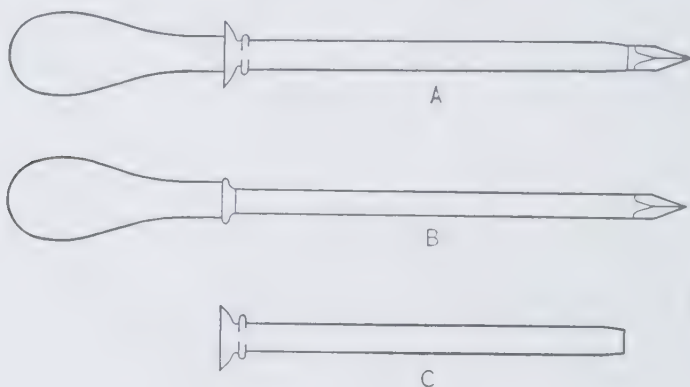


FIG. 106. TROCAR AND CANNULA

(a) Trocar with cannula in position; (b) trocar alone; (c) cannula. This instrument is used in ringing bulls and in treating severe cases of bloat.

ring should be boiled just before they are to be used, or placed in a disinfectant solution for a few minutes.

Hold the nose firmly with one hand and push the trocar, with cannula in place, through the nasal cartilage at a point a little above the lower end of the nostril, where the cartilage is thin. Withdraw the trocar, leaving the cannula projecting through the nose.

D. Pass ring through opening and fasten with screw. Insert the open end of the ring in the small end of the cannula and remove the cannula from the nose, at the same time drawing the ring through the nose. Close the ring and fasten it securely by means of the screw. If the ring or the head of the

screw has become roughened it should be smoothed with a file or sandpaper.

If this operation is performed in a barn that does not have a smooth, clean floor, a canvas or blanket should be spread below the bull's head to prevent loss of the screw, in case it should be dropped.

4. DEHORNING THE BULL

Unless the bull is particularly valuable as a show animal, he should be dehorned. He can then be handled with much less danger, and there is less likelihood of his breaking through his enclosure.

Procedure:

- A. Prevent growth of horns when calf is young, or remove horns when he is one to two years old.
- B. Perform operation in fall or winter.
- C. Tie bull securely.
- D. Disinfect instruments.
- E. Remove horns close to head.
- F. Keep wounds clean.

Equipment:

Scissors, stick of caustic, strong stall, halter, dehorning shears or saw, absorbent cotton, adhesive tape, pine tar.

A. Prevent growth of horns when calf is young, or remove horns when he is one to two years old. If possible, prevent the growth of the horns of the bull calf as soon as the buttons can be plainly felt, which is when the calf is one to two weeks old. This should be done by applying a caustic, as described in Chapter XII. If the growth of the horns was not prevented when the bull was a calf, the horns are best removed when the bull is about two years old. They may be removed when he is a year old, but if the operation is done before this time the stubs may continue to grow.

B. Perform operation in fall or winter. Plan this work for the cold weather, when there are no flies. It should be done as long before warm weather as possible.

C. Tie bull securely. The bull must be tied very securely, as dehorning is a painful operation, often causing the bull to break his stanchion or stall in his excitement. An ordinary cow stanchion is usually not strong enough for a bull more than a year old. Confine the animal in a specially heavy stall or cattle chute, or construct a stanchion of 4 by 4-inch pieces. Make the stanchion strong enough to prevent the bull from lunging forward upon the operators or breaking the stanchion by pulling backward. Place a strong halter on the bull and draw his head sharply to one side.

D. Disinfect instruments. Dehorning shears are generally used for animals not over two years of age. For old animals with large horns, the dehorning saw is considered best. Place the instrument to be used in a strong disinfectant solution for a few minutes before work is begun.

E. Remove horns close to head. Cut the horns at a point close to the head, about $1\frac{1}{4}$ inch below the line where the skin joins the base of the horn. If possible, watch some one do this work before undertaking it for the first time.

F. Keep wounds clean. Bleeding always occurs, but usually stops after a short time. Should the bleeding continue, or be severe, cover the wound with a layer of absorbent cotton fastened in place by means of strips of adhesive tape or of cotton cloth. In warm weather put some pine tar on the cotton to keep away flies. Under no circumstances use dirty materials, such as cobwebs, chaff, etc., to stop the bleeding. Keep the animal away from straw stacks or other places where dirt might get into the wounds.

5. LEADING THE BULL

Every precaution should be taken to prevent the bull from injuring persons or animals, or doing any other damage, while he is being led about.

Procedure:

- A. At an early age, train bull to be led.
- B. Always use staff for mature bull.
- C. Use two men when leading vicious bulls.
- D. Treat every bull with caution and respect.

A. At an early age, train bull to be led. Begin teaching the bull to be led while he is still young. When six to eight months of age, he may readily become accustomed to the halter. Lead him about the barnyard, making him familiar with different conditions, such as the noise of machinery, the sight of other animals, etc. If he is to be exhibited at fairs, train him to pose, as described in Chapter XVIII.

B. Always use staff for mature bull. Do not attempt to lead a well-grown bull without a staff attached securely to a ring in his nose. The bull must be trained to the staff as well as to the halter. In leading the bull with the staff, always walk at his side and never in front of him. Keep his head held high, as a bull can do little damage with his head in that position. Watch him constantly while leading or holding him.

Some staffs are equipped with prongs or teeth which, by a turning of the staff, can be pressed on the bull's nose. This device should not be used except when very necessary.

C. Use two men when leading vicious bulls. Whenever a bull that is known to be vicious, or one that behaves in a dangerous manner, is to be led, always employ two men. Each man may use a staff, each staff being attached to a separate ring in the bull's nose. A common method of leading such bulls is for one man to use a strong staff attached to one nose ring, while the other man uses a heavy strap snapped into a second ring. In either case, the men walk on opposite sides of the bull, keeping abreast of him, and forcing him to hold his head high.

When a vicious bull, or one whose disposition is unknown, is kept in a yard or box stall, make the animal secure before

entering the stall to attach the staff. This may often be done by enticing the bull to the manger by means of some grain mixture, and then snapping a rope or strap in his ring. The bull may then be tied or held by an attendant before the keeper enters the stall with the staff.

D. Treat every bull with caution and respect. Whenever a bull is being led, use caution and have respect for his great strength. Accidents with bulls are not always due to the animals' being vicious, but may result from their becoming frightened. Do not take chances when leading a bull, but use every precaution to safeguard yourself and others.

6. CONTROLLING THE USE OF THE BULL

Too early or too frequent use of the bull must be avoided, in order to obtain the best results.

Procedure:

- A. Permit the bull to become sufficiently mature before using him.
- B. Limit the use of the bull.
- C. Keep the bull separate from females at breeding season.

A. Permit the bull to become sufficiently mature before using him. Do not allow the bull to be used for service before he is twelve months of age, unless he is much above the average in growth and development.

B. Limit the use of the bull. Until the bull matures (three years of age), the number of females with which he may be mated during a season may be as many as he is months of age. The services of the young bull should be distributed over as much time as possible; it is preferable that they should not occur oftener than twice a week.

Mature bulls may be mated with larger numbers of females than immature bulls, particularly if the breeding season extends throughout most of the year. Under such conditions, one bull may be sufficient in a herd of fifty to sixty cows.

The too-frequent use of the bull is often responsible for the failure of cows to become pregnant and for an early decline in the vigor of the bull.

C. Keep the bull separate from females at breeding season. Do not permit the bull to run with the herd except under the conditions described above in Section 2. Keep him confined in a box stall, yard, or pasture, by himself. Permitting the bull to run with the herd during the breeding season not only makes it impossible to determine the date upon which cows are due to calve, but also may seriously reduce the vigor of the bull.

7. FEEDING THE MATURE BULL

The bull should be kept in good flesh by liberal feeding of concentrates, with limited amounts of good roughage.

Procedure:

- A. Provide roughage of good quality.
- B. Feed concentrate mixture liberally.

A. Provide roughage of good quality. Provide pasture for the mature bull, if possible. He should not be expected to secure all his feed from pasture, but he will be much better off if he has a little fresh green grass. If not possible to provide pasture, take a small amount of fresh grass or soiling crops to the bull frequently.

During the time pasture or green crops are not available, feed some good-quality legume hay in limited amounts. As a paunchy bull is considered undesirable, the amount of hay should not exceed $\frac{3}{4}$ pound daily per 100 pounds live weight. For the same reason, the amount of silage fed should not exceed 1 pound daily per 100 pounds live weight.

B. Feed concentrate mixture liberally. It is obvious that with the limited amounts of roughage suggested, concentrates must be fed to keep the bull in good flesh. Do not permit the bull to become fat unless he is to be exhibited at fairs, since bulls are much less active when fat.

When legume hay and silage in the amounts suggested above form the roughage, it is necessary to feed about 3 pounds of a good concentrate mixture daily per 1000 pounds live weight in order to maintain the bull in fair condition. A mixture composed of equal parts of ground corn, ground barley, or hominy with ground oats or wheat bran, is suitable for use during the non-breeding season. During the remainder of the year, supply the bull with a sufficient amount of a concentrate mixture containing more protein, such as the mixture being fed the cows in milk. During the period of heavy service, it may be necessary to feed more than 3 pounds daily for each 1000 pounds live weight.

8. HOUSING AND EXERCISING THE BULL

On many farms but little importance is attached to the kind of quarters and the opportunity for exercise given the herd bull. Too often the bull is tied closely in a dark, dirty shed, with no outdoor exercise. Since the herd bull has a much greater influence on the success of the herd than even the best cow, he should be kept in the best of health and condition by means of comfortable quarters and regular exercise.

Procedure:

- A. Provide comfortable stall.
- B. Keep stall well bedded.
- C. Arrange yard or paddock adjoining stall.
- D. See that the bull exercises regularly.

A. Provide comfortable stall. Provide a large, roomy box stall or separate building for the herd bull. For a Jersey or Guernsey bull, a stall 10 by 10 feet in size may be sufficient. A mature bull of the other dairy breeds needs a stall 10 by 12 feet or larger. Do not keep a herd bull confined constantly in a stanchion or tied in a very narrow stall. It is very desirable to have a stanchion in the stall, however, for confining the bull while the stall is being cleaned or while the staff is being attached, etc. Further, do not keep a bull tied in his

stall by means of his nose ring, as this makes his nose so tough that it is difficult to lead him with a staff. If it is necessary to keep the bull tied, provide an extra heavy neck strap made of several thicknesses of leather, with a large iron ring and heavy chain.

For northern climates, it is best to have the bull's box stall in the part of the barn where the milk cows or young stock are

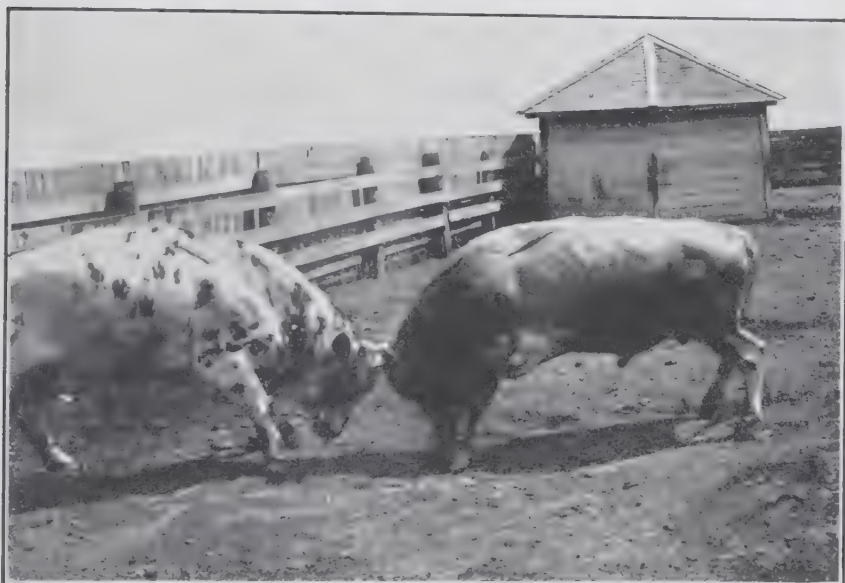


FIG. 107. ONE METHOD OF EXERCISING BULLS

Bulls are sometimes housed together so that their fighting will keep them well exercised. The method can not be recommended as a general practice, on account of the danger of injury.

kept, so that he may be comfortably warm in winter. In sections where the climate is not severe, a separate barn or open shed may be suitable.

Although barns in which the milking herd is kept should be provided with a good floor, such as concrete, the separate bull barn or open shed for the bull may have only a clay dirt floor, if there is good drainage. To prepare a clay floor, scrape the ground free from straw, sticks, and loose surface dirt, and

cover with a 5- or 6-inch layer of fresh clay which is free from stones. While the clay is damp, tamp it solid and allow to dry for a day or two before using. A stall or yard paved with cinders is not desirable, because the cinders cause sores between the hoofs.

B. Keep stall well bedded. In the summer, use only enough bedding to keep the bull from becoming badly soiled, unless bedding is cheap and plentiful; in this case, of course, it may be used freely at all times. In winter, it is essential that



FIG. 108. A WELL-DESIGNED EXERCISING YARD FOR A BULL

The yard is sheltered on the west, north, and east by buildings and a solid wall. In the foreground at the right is a breeding stall to which the bull may be admitted by opening the gate outward a few feet. The gate and fence are constructed of 2 x 6's bolted to the posts. Note the bracing of the posts. With these arrangements it is rarely necessary to enter the bull's quarters.

plenty of bedding be used, so that the bull will not have to lie on cold or damp floors. An ample supply of bedding helps to keep the bull comfortable in cold weather.

When the stall has a dirt floor, bedding can be saved, and at the same time the stall can be kept in first-class condition by using a layer of shavings on the ground with a good covering of straw on top.

C. Arrange yard or paddock adjoining stall. Arrange an exercising yard or paddock leading out from the bull's stall, so that he can be turned out for exercise daily or whenever the

weather is not too stormy. By having the yard in direct connection with the stall, unnecessary leading of the bull is avoided.

The yard need not be paved, but good drainage should be provided. When the bull is permitted to stand in mud puddles or filth, foot rot or other diseases may occur. Grade the yard, filling depressions and providing sufficient slope so that water drains off quickly. With some types of soil, paved yards are very desirable. Gravel consisting of large smooth stones, brick, or concrete, may be used for paving. Finely crushed rock and cinders are not good for this purpose.

Do not fail to provide a strong wall or fence about the yard.

D. See that the bull exercises regularly. Some bulls take enough exercise when given the freedom of the yard or pasture adjoining their stall. Other bulls under the same conditions will not move about much, and some way must be found to make them exercise. A barrel or stump for the bull to bunt about may be placed in the yard. Some bulls, when young, may be trained to work and used just as an ox is used in drawing loads.

9. CARING FOR VICIOUS BULLS

Many bulls of good breeding are sold for slaughter when but three or four years of age, either because they are difficult to handle or for fear they will soon become vicious and dangerous. While there is great danger in handling bulls that have ugly or vicious dispositions, some of the well-bred animals could be retained longer if suitable arrangements for housing them were available. The following suggestions for providing such arrangements have been tried out successfully.

Procedure:

A. Provide strong quarters for the bull.

B. Arrange breeding pen in connection with the bull's quarters.

A. Provide strong quarters for the bull. The stall in which a vicious bull is kept and the fences surrounding the yard in

which he takes his exercise should be made so strong that there will be no danger of his breaking out. When once a bull has broken through a fence, he often tries to repeat the performance. Box stalls in the barn may be equipped satisfactorily with a modern bull pen made of heavy steel tubing. Such pens are strong, may be readily cleaned, and permit the caretaker to observe the actions of the bull.

When the bull stall is to be constructed of wood, line it on



FIG. 109. COMFORT WITH FREEDOM

A nearer view of the bull shelter shown in Fig. 108. The doorway which opens to the south may be closed in severe weather by means of a sliding door operated from the main barn by a rope and pulley.

the inside with 2-inch plank, bolting or nailing the plank to strong posts securely set in the ground or fastened to the framework of the building.

Make the exercising yard equally secure. It may be enclosed by solid walls of stone, brick, or concrete. Another plan is to use large cement posts with horizontal openings 10 to 12 inches apart through which iron pipes of $1\frac{1}{4}$ to $1\frac{1}{2}$ inches inside diameters are placed. In making such a fence, thread each piece of pipe and join the pieces firmly by couplings or

unions. Use not less than five horizontal bars of pipe, and have the posts not more than 8 feet apart. The total height of the wall or fence must be 5 or 6 feet.

Wooden fences are satisfactory if strongly constructed and kept in repair. In constructing wooden fences, use posts 9 or 10 feet in length and 6 inches or more in diameter, and set them about 6 feet apart. Nail the poles or plank (2- by 6- or 2- by 8-inch pieces) on the inside of the posts so that the fence is smooth on the side next the bull. Place the poles or plank so close together that there is no chance for the bull to get his head between them, and so near the ground that he can not get his head below them.

If the stall is provided with a wooden manger, place one or more planks above the manger so that there will be no possibility of the bull's getting his feet in the manger or climbing out of the stall by way of the manger.

B. Arrange breeding pen in connection with the bull's quarters. The need for handling the bull may be greatly lessened by arranging a breeding pen as part of the bull's quarters. Figure 110 shows such an arrangement.

When a cow is to be bred, close gateways *B* and *C* and bring the cow into the breeding pen through gateway *A*. Then close

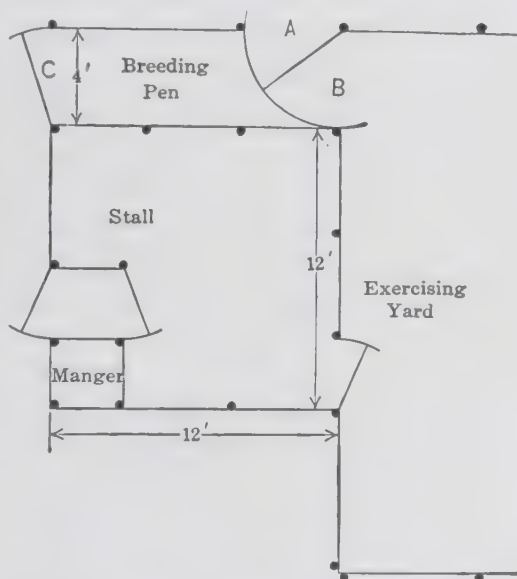


FIG. 110. FLOOR PLAN OF BULL STALL AND EXERCISING YARD

For a discussion of this plan, see Section 9 of this chapter.

gateway *A*, thereby opening gateway *B*. In removing the cow, first force the bull into the exercising yard and close gateway *B*. Then lead the cow out through gateway *C*.

10. RETAINING A GOOD BULL

It is worth while to devise ways of using a good bull for as many years as possible. In grade herds in which the milking herd is replenished by the purchase of cows, little attention is given the quality of the herd bull, and when his usefulness ceases he is sold for beef. In herds in which calves are raised to maturity, however, much care must be exercised in the selection and use of the bull if good calves are to be secured. Most dairy herds are of such size that not more than one herd bull is kept; and here the problem is to secure another bull whenever the daughters of one become of breeding age, which is about every two years, in order to avoid inbreeding in the herd.

Many bulls are sold before their real worth has been discovered. The first daughters of a bull usually do not complete their first lactations until their sire is about five years of age. Unfortunately, relatively few bulls are kept to that age; and if the daughters are later found to be exceptionally good milkers, it is usually then too late to get the bull back.

There are several ways in which a bull may be kept in service until his real value is known. One of the most practicable is by the use of a cooperative bull association. In the absence of such an association, two or three neighbors may exchange their bulls every two or three years; or, in the case of valuable purebred herds, some of the more promising bull calves may be loaned or leased to smaller herds for a few years. In large herds where two or more herd bulls are kept, inbreeding may easily be avoided for some time, and bulls may therefore be retained for a much longer time than if there were but one bull at the head of the herd.

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COMMUNITY STUDIES

Visit several of the leading dairy herds of the community and pay especial attention to the care given the herd bulls. Include among the farms visited one or more that have herds of purebred dairy cattle and make a specialty of raising valuable breeding stock.

1. Is the bull calf that is being raised to head the herd given any better care than the heifer calves?
2. How is the bull calf fed and cared for?
3. At what age is the bull calf separated from the heifers?
4. What methods of exercise and what kind of quarters are provided for the young bull?
5. At what age is a ring put in the bull's nose?
6. What kind of a ring is used?
7. Was the bull dehorned when a calf, or if not, at what age?
8. How was the dehorning done?
9. Is the bull led by a rope or staff, or both?
10. If a staff is used, how is the bull caught, and the staff attached?
11. At what age is the bull put into service, and to how many cows is he mated during the season?
12. What kind of shelter is provided for the bull?
13. Does the plan of housing the bull keep him comfortable and provide plenty of sunshine and fresh air?
14. What method of exercising the bull is used?
15. If an ugly or vicious bull is kept, how is he housed and used?
16. What is the construction of walls and fences about the bull's shelter and yard?
17. How many years is the bull kept in service?

CHAPTER XV

MANAGING THE DAIRY HERD

Good management of the dairy herd involves not only careful planning and supervision of the larger breeding and feeding programs, but also close attention to the dozens of minor problems that arise in connection with a livestock enterprise. Watchful care is needed at calving time, in providing comfortable conditions at all seasons, and in carrying out the daily routine operations.

Operations:

1. Numbering stalls.
2. Identifying cows.
3. Marking cattle.
4. Arranging the daily stable program.
5. Determining the time for freshening.
6. Giving the cow a rest.
7. Caring for the cow at freshening.
8. Milking a cow at first calving.
9. Milking cows more than twice daily.
10. Preventing cows from kicking.
11. Preventing cows from sucking.
12. Keeping the cows comfortable.
13. Providing drinking water.
14. Protecting cows from flies.
15. Grooming cows.
16. Dehorning cows.

1. NUMBERING STALLS

It is essential that each cow in the herd occupy the same stall whenever she is in the stable, and that she be known by a name or number placed in a conspicuous place on the stall. The

name or number should be written or printed on both sides of a placard so that it may be read from either the front or the rear of the stall. The caretaker who knows his cows can then make certain that each cow enters her own stall when the cows are admitted to the barn, and also can quickly ascertain the herd numbers of the cows at feeding and milking times so that fewer mistakes will be made in the records.

Procedure:

- A. Secure name plates.
- B. Attach name plates to stalls.
- C. Label name plates.

Equipment:

Name plates, wrench, thin boards, saw, hammer, nails, paint, paint brush, chalk.

A. Secure name plates. The most satisfactory name plates for modern stalls constructed of steel piping are those manufactured for the purpose by the makers of the stalls. The plates are of several different types, but perhaps the most practical is the kind that consists of a cast-iron or pressed steel frame with clips for bolting to the horizontal top rail of the stall. The frame contains a removable cardboard or light wooden board for lettering with crayon.

Homemade name plates may be used and are suitable, especially for wooden stalls. Cut pieces of beaver board or thin wooden board about 5 by 12 inches in size.

Thin boards from packing boxes may be used. Paint the boards black and allow to dry.

B. Attach name plates to stalls. Metal name plates are usually provided with castings or clips for attachment to the horizontal top rail of the stall. Loosen the bolts and clamp to the rail, tightening the bolts securely.

Wooden name plates should be attached to the horizontal wooden top rail of the stall. Nail the name plate board to the

top rail, placing it so that the board extends about 4 inches above the rail.

C. Label name plates. As short names are preferable for use on the name plates and record sheets, it is common practice to designate purebred cows having several names either by number or nickname. Print the herd number or nickname on both the front and the back of the name plates. Common white crayon may be used satisfactorily on the black painted



FIG. 111. CLEAN PASTURES HELP TO KEEP THE DAIRY HERD HEALTHY
Good pastures help to promote good health and resistance to disease.

boards. The crayon may be readily erased and the number changed if the cow is given a different stall.

2. IDENTIFYING COWS

Unless the cows in the herd can be readily identified, it is impossible, of course, to keep production records. The cows must be taught to enter their individual stalls so that each time they are admitted to the stable they will enter them of their own accord; but the caretaker should be able to recognize the animals quickly, so that if at any time any cows should exchange stalls, he will instantly know it. Even though the caretaker may know the cows, it is desirable to have a permanent record of the identity of each animal in case of a change in milkers or of the sale of the cattle.

Procedure:

- A. Secure record blanks.
- B. Sketch color markings.
- C. File records.

Equipment:

Record blanks, pen, pencil, 10- by 12-inch board, thumb tacks.

A. Secure record blanks. Secure a supply of loose-leaf record blanks for keeping breeding records. These may be had from one of the breed associations listed in this book, or from firms given in the references at the end of this chapter. Home-made forms may be made by laying a sheet of carbon paper over a sheet of plain paper, then laying a picture of a cow on the carbon paper and tracing the outline of the cow by means of a blunt soft pencil. Several forms may be made at one time by the use of several sheets of carbon paper, each one being placed between sheets of plain white paper.

B. Sketch color markings. Fasten several of the blank forms to a 10- by 12-inch board by means of thumb tacks. Take the board into the stable and sketch from the cows the outlines of the color areas. One person should hold the animal at the halter while the one doing the sketching sits on a chair or box so that his eyes are about on a level with the center of the animal's body. Indicate the color in the larger areas by an appropriate letter, such as B for black, F for faun, etc. The dark areas may be shaded later, by drawing straight lines through them. Be sure to enter the number or name of the animal on the sheet showing its markings.

For a cow of solid color, a description of the animal, including mention of any special features, should be entered on the record blank. Some of the items to be mentioned in such description may be the shape of the horns, whether upturned, curved inward, or downward; color of tongue and switch; solid body color, whether light or dark shade.

Small photographs of individual animals pasted on the record blanks are superior to descriptions or color tracings, as they indicate the individual characteristics of the animals.

C. File records. Collect the records of the color markings and file them alphabetically according to the names of the cows, or numerically according to herd numbers. The records should be kept in a convenient place so that the breeding records, such as calving dates, etc., can be entered on them.



FIG. 112. POOR CONDITIONS FOR THE PRODUCTION OF HUMAN FOOD

The tumble-down structure at the right was used for many years to house the dairy cows on this farm. It is said that a boy's fingers were frozen while he was milking cows in this shanty. A herd managed in this manner can not be expected to yield good returns. The other livestock on the farm were given much better shelter.

3. MARKING CATTLE

There must be some means by which every animal in a purebred herd can be readily identified. This is also desirable in many grade herds, for accurate breeding records can not be kept unless the herd number or name of each animal is known or can be quickly found. A good system of marking the cattle gives a buyer much greater confidence in the accuracy of the records. There are several different systems of marking cattle, at least one of which should be used in every purebred herd or

large grade herd. The more important of these are outlined below:

(1) **Trace color markings.** Directions for this procedure and for filing the records are given in Section 2 of this chapter.

(2) **Employ neck straps and numbered tags.** Secure a supply of numbered brass tags, and straps about 1 inch wide, fitted with buckles. The straps should be 3 or 4 inches longer than necessary to reach around the calves' necks, in order to allow for increase in size of the necks.

Place a strap bearing a numbered tag on each calf at the time it is separated from its mother. Record at once in the herd breeding records the name or herd number of the calf, together with the number of the tag used.

Tags of this sort are easily read, and the system is very convenient to use, but the tags are relatively expensive.

(3) **Fasten tags in ears.** Purchase some numbered metal tags, together with pliers for fastening them in the ears. The tags may bear the name and address of the owner, if desired.

Fasten one of these tags in the ear of each calf in the herd before it is separated from its mother. Do not close the tag tightly, but leave space for the ear to grow.

(4) **Tattoo ears.** Tattooing may be done when the calf is about one year old. It is of little value with cattle having dark-colored skin in the ears.

Wash the skin on the inside of the ear with soap and water to remove grease. Make the puncture with the tattoo marker and rub in the tattoo oil thoroughly.

4. ARRANGING THE DAILY STABLE PROGRAM

On farms where men are employed to spend their entire time in caring for the dairy herd, regular hours for performing each operation are naturally adopted. On farms where the men milking and caring for the cows are also employed in general farm work, there is a tendency to give the cows insufficient

care and, especially during rush seasons, to neglect them. In these cases it is very important that a regular program be planned and followed out.

Procedure:

- A. Adopt a definite program.
- B. Make periods between milkings as uniform as possible.
- C. Feed regularly.
- D. Allow time for extra duties.

A. Adopt a definite program. The particular order in which many of the stable operations are performed is immaterial, but it is very important that these operations be carried out at regular hours and that the same order of procedure always be followed. Therefore, adopt a definite program which best fits your conditions and keep to it as closely as possible.

B. Make periods between milkings as uniform as possible. The maximum amount of milk is secured when the cows are milked at regular intervals which will divide the twenty-four hours as evenly as may be practical. Consider this fact in arranging the stable program.

C. Feed regularly. Cows learn to expect their feed at certain times. Arrange the work so that the feeding will be done at the same hours each day. Feeding is generally done near the milking hour; therefore, the dividing of the milking periods as evenly as practical, as suggested above, is also a benefit in distributing the feeding times uniformly through the day.

D. Allow time for extra duties. In planning the program, allow a little time which can be spent in looking after some of the details of herd care, such as treatment of inflamed udders, care of cows at freshening, changing record sheets, etc. Looking after the small details is very necessary in successful herd management.

5. DETERMINING THE TIME FOR FRESHENING

When pasture is abundant and cheap and the supply of feed for the winter months scarce or very high priced, it is often desirable that most of the cows freshen during the early spring months. Pasture usually provides feed more cheaply than any other source, so that cows freshening in the spring make the most profitable use of pasture.

The prices received for milk or cream during the different seasons must, of course, be taken into consideration also. Even with higher feed costs during the winter months, the greater prices usually received for dairy products during the winter season may make it profitable to have the cows freshen in the fall. It is generally believed that fall-freshening cows, if well fed and cared for, produce more milk in a year than spring-freshening cows.

Some herds are expected to furnish a uniform amount of milk throughout the year. If so, it is best to have about half the cows freshen in the spring and the other half in the fall.

The freshening of cows in midsummer or midwinter is not a good practice on account of the danger of extreme temperatures affecting both milk production and the health of the young calves.

Most dairymen prefer to have the cows freshen annually, except in special cases in which cows are being tested for maximum production records.

6. GIVING THE COW A REST

Cows that naturally give but small quantities of milk tend to remain dry for three to four months of the year. Cows of exceptional dairy tendency, on the other hand, may continue to give milk from one calving to the next. This is a severe tax upon the vitality of the cow and should seldom, if ever, be permitted. In order that some systematic arrangement may be made to secure as great an annual yield of milk as possible

and still have the cows in good condition for the next freshening, follow the suggestions given below.

Procedure:

- A. Determine date of freshening.
- B. Dry off the cow.
- C. Feed liberally.

A. Determine date of freshening. Consult the breeding records and determine the dates on which the different cows are expected to calve. Make a list of these dates and also of the dates on which the cows should be turned dry.

In deciding upon the date for drying off a cow, consider her condition of flesh and ability as a milker. Cows having good dairy ability should have six to eight weeks to rest and put on good flesh before calving. Cows of only mediocre dairy ability do not need more than six weeks' rest, as a rule, although they usually are dry for a longer time. Further, it is not necessary that they be in as high a state of flesh at calving time.

Place the list containing the dates when the cows are expected to calve, and when they should be turned dry, in a conspicuous place, preferably beside the milk-record sheet. In herds in which cows freshen in several different months of the year, it may be best to make out a new list on the first day of each month and post it together with the new milk-record blank.

B. Dry off the cow. There is little difficulty in drying off cows that are not persistent milkers. The milk yield declines to nothing even though regular milking is practiced. For high-producing, persistent cows the method given below, known as "sealing the udder," is recommended.

Milk the cow once daily for at least a week and until the milk yield has declined to not more than 30 pounds a day. Two to three days before the udder is to be sealed, reduce the amounts of grain mixture and silage to one-half the usual amounts. To seal the udder, first wash clean; dry with a

clean towel; disinfect ends of teats with tincture of iodine, or other good disinfectant; apply a small amount of collodion, using for the purpose a piece of surgical cotton or cotton bandage on a clean stick, or a glass swab fitted to the stopper of the bottle.

Keep a cow with a large udder in a box stall until the

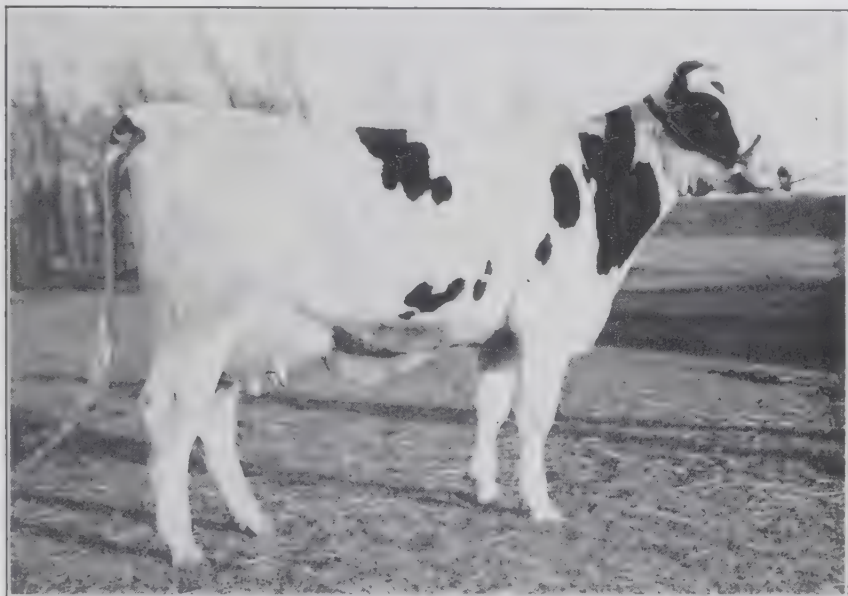


FIG. 113. HEIFERS SHOULD BE IN A GOOD CONDITION OF FLESH AT CALVING TIME

Heifers that are well grown and in good flesh at calving time are capable of greater production than poorly fed, undersized heifers. The lymph deposit on the underline in front of the udder is a normal occurrence in well-fed heifers. The deposit usually disappears within a few days after calving.

swelling has subsided, because the swinging of a large udder which may occur when the cow is turned outdoors may cause injury. Beginning with the fourth day after the udder is sealed, restore full feed to the cow. Watch the cow closely and if the seal on one teat breaks, milk out all four quarters and reseat, using the same precautions as before.

This method of drying off cows should not be attempted

with any cow showing evidences of mastitis, such as stringy or bloody milk.

C. Feed liberally. Feed the cow during the dry period so that she will be in a good state of flesh at calving time. If she is thin in flesh, begin to feed her quite heavily during the early part of the dry period, so that it will not be necessary to feed more than a small ration during the ten days prior to calving.

Cows on good pasture need little or no additional feed during the dry period, unless they are in thin flesh, in which event grain mixture should be fed in addition. When pasture is not available, feed hay and silage liberally instead. To cows in moderate flesh, feed 2 to 4 pounds of grain mixture daily in addition to roughage. To cows in thin flesh, feed 4 to 6 pounds daily of a grain mixture such as the following:

- (1) 200 pounds ground corn, hominy feed, or ground barley;
- (2) 100 pounds ground oats or wheat bran.

For a period of ten days to two weeks before calving, provide feeds that will exert a laxative effect on the cow. Pasture furnishing plenty of green grass, or liberal amounts of legume hay or silage, will usually suffice; but if only dry feed is given and good legume hay is not available, feed a concentrate mixture such as one of the following:

- (1) 100 pounds ground oats, 100 pounds wheat bran;
- (2) 200 pounds ground oats, 100 pounds linseed meal;
- (3) 100 pounds each of ground oats, wheat bran, and linseed meal.

Feed 2 to 4 pounds of the mixture daily, depending upon the condition of the udder. If the udder becomes badly caked, omit grain feeding and feed legume hay liberally, with a small amount of silage or roots.

7. CARING FOR THE COW AT FRESHENING

If the cow has been fed in accordance with the suggestions given above, she should be in such good physical condition

that most of the troubles that frequently follow calving will be avoided.

Procedure:

- A. Provide clean, well-bedded box stall.
- B. Keep cow warm.
- C. Do not milk cow before she calves.
- D. Assist cow in calving only if necessary.
- E. Give cow warm water.
- F. Provide laxative feeds.
- G. Make sure that calf nurses.

A. Provide clean, well-bedded box stall. Directions for cleaning the stall have been given in Section 2 of Chapter XII. Put a liberal quantity of clean, dry bedding in the stall.

Follow the breeding charts closely and note when a cow is expected to calve. As the actual date of calving may be as much as a week or ten days earlier or later than the expected date, one must watch the cow for signs of approaching calving. As soon as it seems likely that she will calve in two or three days, keep her in a box stall instead of a stanchion, while she is in the barn.

B. Keep cow warm. Whenever a cow freshens during cold weather, careful attention must be given her. Do not permit cold drafts to blow on her, nor turn her outdoors if the weather is very cold. If the stable is not warm enough to be comfortable, keep a blanket on her for a few days. An abundance of dry bedding also helps to keep her warm.

C. Do not milk cow before she calves. The udders of good dairy cows usually become large and swollen before calving. It often seems that the cow should be milked in order to relieve the strain on the udder, but this should be done rarely, if ever. However, heifers before first calving that show an unusual distention of the udder may safely be milked because they are seldom subject to milk fever. Very little milk is obtained the first day but beginning with the third day the milk yield rises

rapidly and may reach 30 to 40 pounds daily before calving.

D. Assist cow in calving only if necessary. Most cows are able to give birth to their calves without assistance, and in such cases they should not be disturbed. Occasionally, however, help must be given. One should not attempt to assist a cow that is having difficulty in calving unless he is experienced or has the help of an experienced person.



FIG. 114. HEAVILY CAKED UDDERS OF HEIFERS NEED RELIEF

When prior to her first calving the udder of a heifer becomes as badly caked as the one illustrated here, it is usually desirable to relieve the pressure in the udder by milking regularly and massaging in an upward direction several times a day.

E. Give cow warm water. A cow is usually thirsty after calving and would drink a large amount of cold water if given access to it. In cold weather, however, she should not have it, as it might result in giving her a severe chill. Give her water that has been warmed slightly, and for a few days provide water which is not colder than that coming from a deep well.

F. Provide laxative feeds. After the cow has calved, provide feeds that will keep her bowels moving freely. See Section 6 of this chapter for directions for feeding. If the cow seems to be constipated, give her a dose of Epsom salts, following the directions given in Chapter XVI, Section 4.

G. Make sure that calf nurses. It is necessary that the calf receive some of the first milk, or colostrum. Sometimes a calf is too weak to nurse without assistance. When this is the case, assist the calf in standing and in grasping the teats. If it is too weak to stand even with help, feed it some of its mother's milk from a bottle.

8. MILKING A COW AT FIRST CALVING

Cows calving for the first time are often hard to milk on account of their timidity and fright. This difficulty can largely be overcome by following the suggestions outlined below:

Procedure:

- A. Accustom heifer to stall.
- B. Handle heifer before she calves.
- C. Use gentle methods in milking and caring for cow.
- D. Develop short teats.

A. Accustom heifer to stall. If a heifer has not been kept in the stall which she is to occupy after she becomes a member of the milking herd, teach her to enter this stall and to occupy it for two or three weeks previous to calving.

B. Handle heifer before she calves. Accustom the heifer to the presence and touch of a person by spending a few minutes each day, for two or three weeks before calving, in handling her gently. A good way to begin, if the heifer has never been handled, is by gentle patting or by brushing with a stiff brush. Later, rub and handle the udder gently.

C. Use gentle methods in milking and caring for cow. Try to develop good habits in the young cow by gentle treatment. Since the udder is very tender at first calving, use care not to hurt the cow when milking her. Refrain from shouting at the cows or striking them when letting them into or out of their stalls.

D. Develop short teats. The teats of some cows are so short at the time of first calving that it is very difficult to milk them. It is sometimes possible to cause the teats to become longer by stripping them gently every day or two, three or four months before calving. There is danger, however, that this procedure, if continued too long or practiced too vigorously, may result in the formation of milk in the udder. A common method of milking such a cow is to permit one or more calves to nurse her for three to four weeks after calving. This helps not only to lengthen the teats, but also to remove some of the inflammation from the udder.

9. MILKING COWS MORE THAN TWICE DAILY

Milking more than twice daily does not materially increase the milk flow of low-producing cows, but has a very decided effect upon the yield of high-producing cows. When labor is available, it may be a paying practice to milk high-producing cows three or four times daily.

Procedure:

- A. Select cows to be milked more than twice daily.
- B. Arrange regular hours for milking.
- C. Determine economy of procedure.

A. Select cows to be milked more than twice daily. A cow of one of the larger breeds, such as the Holstein, which is capable of producing more than 50 pounds of milk daily, may well be milked three times a day. If she is capable of producing more than 75 pounds a day, it may pay to milk her four times a day. If she is a registered animal, it may be desirable to test her for Advanced Registry.

The yield of Jersey or Guernsey cows producing more than 35 pounds of milk daily may usually be increased by milking three times a day. When cows of these breeds produce upwards of 50 pounds daily, milking four times daily is recommended.

B. Arrange regular hours for milking. If the herd cows are milked regularly at 5 A.M. and 5 P.M., the "three-time" cows may be milked at 5 A.M., 1 P.M., and 9 P.M. If it is impossible to have four different milking periods during the day, the three-time cows may be milked before the other cows in the morning, again at 12 noon or 1 P.M., and then after the other cows at the 5 P.M. period. When milking four times a day,



FIG. 115. UNTRIMMED FEET MAY CAUSE LAMENESS

The hoofs of this cow have grown so long that the cow is likely to become lame or to walk with an uneven gait. Occasional trimming by means of a hammer and chisel is needed.

arrange the milking periods at six-hour intervals, having two of the periods the same as for the regular herd cows, such as 5 A.M., 11 A.M., 5 P.M., and 11 P.M.

C. Determine economy of procedure. Keep a record of the amount of milk being produced daily by each cow before and after milking three or more times daily. Compute the value of the additional milk secured and decide whether or not the

extra labor required should be spent in this way or in some other work.

10. PREVENTING COWS FROM KICKING

In most cases, kicking can be prevented by making sure that the cow is not hurt or frightened.

Procedure:

- A. Accustom heifer to being handled.
- B. If cow kicks, discover and remove cause.
- C. Use hobbles on persistent kickers.

A. Accustom heifer to being handled. Handle the heifer, before calving, until she becomes accustomed to the touch of a human being and is docile and unafraid. This is the best insurance against her becoming a kicker after calving.

B. If cow kicks, discover and remove cause. A cow usually kicks because she is hurt or frightened. The udder may be very tender after calving, or the teats may be sore. Unusual noise and the presence of strange persons or dogs are also causes of kicking. Try to find the cause and remove it. For treatment of sore teats, see Chapter XVI.

Do not strike or kick the cow, as this makes matters worse.

C. Use hobbles on persistent kickers. When a cow persists in kicking after all relief measures have been tried, secure a set of hobbles and fasten them on her legs shortly before attempting to milk. Fit the hobbles on the legs just above the hocks and adjust the connecting chain so that the cow can stand but can not kick.

Do not tie a rope about the cow's body, as this may result in injury.

11. PREVENTING COWS FROM SUCKING

Some cows develop the habit of sucking themselves or other cows. This reduces the milk yield, of course, and should be prevented.

Procedure:

A. Put anti-sucking device on cow.

A. Put anti-sucking device on cow. Secure a metal anti-sucking device and fasten it in the cow's nostrils. Such a device is very effective.

Another method is to have the cow wear a halter, the nose strap of which is covered by another strap through which sharp-pointed nails project outward. The former method is generally preferred.

12. KEEPING THE COWS COMFORTABLE

Cows should be protected from extremes of temperature, drafts, etc., and kept as comfortable as possible by the methods outlined below.

Procedure:

A. Keep temperature of barn moderate.

B. Prevent drafts from striking the cows.

C. Use sufficient bedding.

D. Provide shade in summer.

A. Keep temperature of barn moderate. The appetites of cows are sharper when the weather is cold than when it is very hot, but neither extreme is desirable. Try to maintain a uniform temperature so far as possible, preferably between 40° and 55° F.

B. Prevent drafts from striking the cows. Provide plenty of fresh air by means of a well-designed ventilation system, as discussed in Chapter XX, Section 1. When the weather is cold, do not permit direct drafts from doors or windows to strike the cows.

C. Use sufficient bedding. Bedding is sometimes very scarce and expensive, but is generally a necessity, since inflammation of the cow's udders is very often due to their

coming in contact with cold floors. Whenever possible, use enough bedding to cover the stall floor completely.

D. Provide shade in summer. Cows suffer from extreme heat as well as from extreme cold. Provide shade trees or a covered shed open on all sides, and give the cows access to the shade for several hours during the hottest part of the day in extreme weather. Some herds are kept in darkened barns



FIG. 116. COWS AT PASTURE SEEK SHADE

Providing shade either by trees or by temporary open shelters in the pasture adds greatly to the comfort of the cows on hot summer days and also helps in keeping milk yields at a high level.

during the day in the hottest weather and turned out to pasture at night. Such a plan is not practical unless the barn can be kept fairly cool and well ventilated.

13. PROVIDING DRINKING WATER

A supply of pure, clean drinking water is essential to the health of cattle and must be available at all times.

Procedure:

- A. Secure water supply from good source.
- B. Clean water tanks and bowls frequently.
- C. Keep water above freezing temperature in winter.

A. Secure water supply from good source. Provide the dairy herd with clean, pure water. That coming from wells, clear running streams, or lakes, is usually satisfactory, but one should not expect cattle to drink water from muddy streams or stagnant pools. The water in stagnant ponds is especially



FIG. 117. FEED OBTAINED FROM PASTURES AFFECTS YIELDS

The yields of pastures and of cows, too, are greatly affected by the rate of stocking the pastures, by the application of manure, and by giving the pasture rest periods. The pasture pictured here is little more than an exercising ground. Under such conditions cows need much supplementary feed in addition to pasture in order to maintain good yields.

undesirable, since it generally contains slimy growths and may contain disease organisms. When the herd is supplied with water from the same source as that used by the family, one can rest assured that the quality of the water given the animals is satisfactory.

B. Clean water tanks and bowls frequently. Large water tanks soon become filthy, especially in warm weather, if not cleaned frequently. Every three or four weeks, drain out the water, and scrub the sides and bottom thoroughly by means of a stiff broom. Rinse thoroughly. Place 3 or 4 pounds of

lime and 1 or 2 ounces of copper sulphate in the tank to keep down the growth which generally occurs. Clean automatic water bowls as often as necessary to keep them free from hay or other feed that falls into them.

C. Keep water above freezing temperature in winter. Cows do not drink as much water when it is ice cold as when it is warmer, and then, too, drinking ice water may chill the cows severely. Warm the water by means of a tank heater, so that its temperature is 50° F. or higher, or provide an underground tank and gravity or pressure system so that the water is always above freezing.

14. PROTECTING COWS FROM FLIES

Lessened milk production during the summer is generally thought to be due to the annoyance of flies. Insufficient feed is probably a more important cause, but flies may be responsible for a part of the loss. Keeping flies off the cows during the milking hour makes milking easier, and keeping them away from the milk lessens the chances of its becoming contaminated with disease germs. Several methods of protecting cattle from flies are given below. One or more of these methods will be found suitable for use on nearly every farm.

Procedure:

- A. Keep barn and lots free from manure and filth.
- B. Spray cows with a fly repellent.
- C. Darken stable.
- D. Place light blanket on cows.
- E. Screen stable and kill flies.

A. Keep barn and lots free from manure and filth. Flies lay their eggs in manure heaps and accumulations of filth containing moisture. Clean the gutters and pens in the barn frequently. Haul all manure from the barn and lots, rotting straw piles, etc., and spread on the fields at least once a week

during the summer. Scrape the surface of the lots in which there is manure, and fill any mud puddles with fresh soil.

If it is not possible to take the manure to the fields frequently, cover manure heaps with tarpaulins or heavy fiber paper. The high temperature which develops under the cover on sunshiny days in summer destroys fly larvae. Spreading the manure thinly in the field, however, is more satisfactory,



FIG. 118. PAVED LOT FOR COWS

The use of a paved lot, such as this, is of especial advantage where high-grade milk is being produced. Cows can be kept out of the mud during rainy weather. The lot can be readily cleaned and the manure saved, whereas in an unpaved lot much manure is lost.

since treatment of the manure pile is seldom thorough enough to destroy all developing flies.

B. Spray cows with a fly repellent. Spray the cows lightly before each milking. They may also be sprayed after milking or just before they are turned to pasture. Some fly repellents blister the skin if applied in too large amounts, so care must be used.

Experiments conducted at the University of Illinois showed that the main advantage of spraying cows with fly repellents was to make milking more convenient. There was no advan-

tage from the standpoint of milk yields in spraying well-fed cows heavily enough to keep off flies from one milking hour to the next.

Do not spray young calves too heavily, as their skin is tender.

C. Darken stable. If cattle are kept in the barn for longer than the milking period, tack tarred building paper to the sash



FIG. 119. HEAVY APPLICATIONS OF FLY SPRAYS MAY CAUSE SEVERE BLISTERING

This cow was photographed in April. The blisters on her skin, caused by excessive use of fly sprays during the summer of the preceding year, had not yet completely healed.

so that no light comes through it, but so that the window can still be opened if desired.

Hang gunny sacks from the upper part of doorway by which the cows enter the barn and a second lot of sacks at the same height 4 or 5 feet outside the doorway. This helps darken the barn and also brushes the flies off the backs of the cows as they enter.

D. Place light blankets on cows. Light blankets for protecting cows from flies may be purchased on the market. These are effective but they are also expensive, since many of them become torn if worn at pasture by the cows rubbing against fences, trees, etc.

E. Screen stable and kill flies. The practice of screening windows and doors of the cow stable and driving out or killing the flies that enter is followed in some instances in which high-quality milk is being produced.

When this plan is followed, screen all windows and doors, and darken the windows with building paper. Provide also an arrangement for brushing the flies off the cows as they enter as described under C above.

As soon as the cows leave the barn, close all the windows and doors except one or two, which are left partly open. Many flies will find their way out. If desired, most of the flies may be killed by using especially prepared sprays or powders. To use these, close all windows and doors after the cattle are out of the barn and spray the insecticide into the air. Leave windows and doors closed for a time after spraying.

Flies may be poisoned by placing about the stable shallow dishes containing milk to which formalin has been added at the rate of 1 teaspoonful of formalin to a quart of milk. Do not permit animals to drink the milk.

Electric fly screens used on some of the windows and doors, and also portable electric fly traps, are effective in destroying many flies in and about dairy barns and milk houses.

15. GROOMING COWS

Use brush and curry comb daily. Give the cows a thorough brushing each day by means of a stiff brush, and remove manure clinging to the thighs or flanks by means of a curry comb. Grooming not only keeps the coat of the cows in a more healthful condition, but also makes possible the production of clean milk.

16. DEHORNING COWS

It is recommended that the horns should not be permitted to grow on dairy cattle unless the animals in all probability will be exhibited in the show ring. Directions for preventing the growth of horns on calves are given in Section 18 of Chapter XII.

The dehorning of heifers or cows is carried out in the same manner as directed for the bull, Section 4, Chapter XIV.

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COMMUNITY STUDIES

Visit some of the nearby herds which are cared for in a good manner and in which records of production are kept. Visits should be made during the winter and during the summer. Observe the methods of caring for the herd, and secure information on the following points:

1. Are the stalls numbered and, if so, how?
2. Is any system used for identifying the cows other than the caretaker's knowing them by sight?

3. If some system of identification is used, of what does it consist and how is it kept up to date?
 4. Is any system of marking used on the calves or other cattle? If so, how is it used?
 5. Is a regular stable program followed, and if so, at what hours are the various operations performed?
 6. Do cows freshen in spring or fall?
 7. How long a rest (or dry) period is given the cows before freshening?
 8. How is the cow cared for at freshening?
 - (a) Is a separate stall provided?
 - (b) Are precautions taken to keep the cow warm?
 - (c) Is the cow milked before calving?
 - (d) Is the water for the cow warmed?
 - (e) Is a bran mash fed?
 9. Is there any difficulty in milking a cow at first calving, and if so, what remedies are used?
 10. Is any effort made to prolong the first lactation period as much as possible?
 11. Are cows milked more than twice daily, and if so, is the practice considered a paying one?
 12. What precautions are taken to keep the cattle comfortable?
 13. If fly repellents are used, what kinds are they and how frequently are they applied?
 14. What precautions are taken to keep the flies out of the stable?
 15. Are yards cleaned frequently and is manure hauled to the fields frequently?
 16. Are cows groomed daily in winter?
 17. Are the flanks and udders of the cows cleaned before milking?
 18. What means are used to keep the drinking water above the freezing temperature in winter?
 19. Are the cattle in the herd dehorned?
 20. At what age are the cattle dehorned and how is the dehorning done?
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CHAPTER XVI

TREATING THE AILMENTS OF DAIRY CATTLE

Dairy cattle are subject to a number of serious infectious diseases over which the caretaker can have little control except that of prevention. There are many ailments of minor character, however, which every herdsman should learn to treat. He should also learn to recognize the more serious diseases and be able to give first aid treatment to animals suffering from them.

When the nature of a disease is unknown, the herdsman should not attempt to treat severe cases or to give medicines unless he is fully competent and experienced. It is often best to secure the services of a competent veterinarian, especially if the affected animal is a valuable one.

Follow the suggestions given below for preventing disease and for providing good care for sick animals. For a discussion of the nature, symptoms, and treatment of the more common ailments, see General Information in this chapter.

Operations:

1. Preventing disease.
2. Providing medicines and instruments.
3. Rendering first aid.
4. Giving general care to sick animals.

1. PREVENTING DISEASE

In the care of cattle, as in other enterprises, it is generally recognized that prevention is better than cure. The following precautions, if carefully observed, will minimize the danger of disease:

Procedure:

- A. Keep barn and lots clean.
- B. Provide good feed and clean water.
- C. Protect animals from extreme weather.
- D. Disinfect barn after disease has occurred.
- E. Use care in disposing of dead animals.
- F. Isolate new animals brought into the herd.
- G. Protect herd from neighborhood infections.

A. Keep barn and lots clean. Remove manure and litter from the barn regularly. Do not allow filth to accumulate in the barn and to become the breeding place for flies and other insects. Scrape or sweep the walls and ceilings once or twice a year and follow with a heavy coat of whitewash or paint.

Keep all lots about the barns well graded so that water drains off quickly. Scrape the surface of the lots that are not in grass several times a year to remove manure accumulated on the surface, and haul the manure to the fields.

B. Provide good feed and clean water. Avoid moldy and damaged feed so far as possible. Moldy silage, grain, and hay sometimes may be fed for several weeks without harm, but dangerous illness may be caused at any time. Pasturing cattle on alfalfa or the clovers immediately after frosts very often proves harmful.

Provide clean drinking water and frequently scrub out all drinking tanks and bowls. Avoid stagnant ponds as sources of drinking water.

C. Protect animals from extreme weather. The udder of the dairy cow is a very delicate organ. The skin covering it is thinner than that on other parts of her body. Turning cows out in a yard where they are exposed to the wind in zero weather may be sufficient to cause inflammation in the udder. The same trouble may occur during extremely cold weather if the udder comes in contact with a bare cement floor or if it is exposed to a cold draft coming through cracks in the wall or around doors.

Protect cattle from extremely hot sun, also, and be sure that they have sufficient fresh water to drink during hot weather.

D. Disinfect barn after disease has occurred. When a single animal is attacked by an infectious disease, such as white scours or abortion, remove the animal at once to a separate barn or shed where it will not come in contact with the rest of the herd. Then disinfect the stall or parts of the barn in which the animal has been. When several animals in the herd have been infected, it is often best to disinfect the whole barn after they have been removed.

First clean the barn thoroughly. Remove all manure, feed, and litter, scraping walls, floor, stalls, cupboards, etc., so that the wood or masonry shows a clean surface. Use sharp-edged tools, such as shovels, spades, and special scrapers for flat surfaces, and wire brushes for both flat and rounding surfaces. Burn or bury the material removed.

Most disinfectants are powerful poisons and great care must be exercised in their use.

One of the most economical and yet most effective disinfectants is lye, that is, the common lye used for household purposes and usually sold in 1-pound cans. Used at the rate of one can of lye to 10 gallons of either hot or cold water, this disinfectant has been found very effective for use in stables, provided the surfaces are clean and the lye solution is used liberally. A 5 per cent solution of crude carbolic acid, made by mixing 7 ounces of the acid in a gallon of water, is also very effective but may leave an objectionable odor in a barn where milking is done.

The disinfectant is best applied by means of a spray pump. Soak the walls, floors, and mangers thoroughly. Use a stiff broom or wire brush to work the disinfectant into woodwork or masonry which has rough surfaces. After the job of disinfection has been completed, rinse out the mangers with clean water. Leave doors and windows open to permit the barn to dry out.

It is impossible to disinfect dirt floors completely. If dirt floors are used in stables in which cattle have reacted to tests for tuberculosis or abortion, a temporary measure of protection for use during the winter when the ground is frozen is cleaning the floors thoroughly and then covering them completely with a layer of quicklime to a depth of $\frac{1}{2}$ to 1 inch. As soon as the soil is workable, the dirt floors should be removed to a depth of 4 or 5 inches, the adjoining walls cleaned and disinfected, and then a new floor installed. The new floor preferably should be of cement construction, but if this is not possible, replace it with clay obtained from a location not contaminated by livestock.

E. Use care in disposing of dead animals. Too much care cannot be used in the prompt disposal of dead animals and in the disinfection of the stall or ground with which the body has been in contact.

Remove the body of a dead animal promptly to a safe distance from the farm buildings and from all fields to which the cattle have access. Burn the carcass or bury it 5 or 6 feet deep. When animals die at pasture, it is sometimes best not to move the body but to burn or bury it there. If it is to be burned, lay sticks of wood on the ground and by means of poles tip the body over on the wood. Lay a sufficient amount of wood about the body to burn it completely, and burn the poles used in moving the body. If the body is buried, sprinkle fresh lime on the surface of the ground where the animal lay.

The practice of removing the hide from dead animals is not a safe one unless it is known with certainty that the cause of death was not an infectious disease which might be contracted by a person handling the carcass.

Burying animals at a shallow depth in lots or pasture may cause the spread of disease.

F. Isolate new animals brought into the herd. Put new animals to be added to the herd in a separate barn or shed for a week or ten days, to find out whether or not they are infected and are coming down with some disease.

G. Protect herd from neighborhood infections. When cases of infectious disease, such as tuberculosis and Bang's disease, are known to have occurred on neighboring farms, special precautions are needed.

If pastures receive drainage water from adjoining farms, relocate these pastures, if possible, in order to avoid this drainage. If the pastures adjoin those of another farm, construct a temporary fence 12 to 15 feet inside the line fence to prevent the possibility of direct contact of the animals. Keep feed alleys of barn well swept, and as far as possible prevent visitors who come from neighboring farms from walking over feed. Keep birds out of hay mows, silos, feed bins, and mangers.

2. PROVIDING MEDICINES AND INSTRUMENTS

Every dairy barn should be equipped with some of the more common medicines and instruments for treating simple ailments. Secure a supply of common medicines and instruments such as those suggested below. A special cupboard should be provided in the barn for storing these supplies. For the principal uses of each of the following, see the discussion of common ailments in the section on General Information below.

Medicines (for herd of 20 cows):

Epsom salts, 10 lb.

Tincture of iodine, 2 to 4 oz.

Disinfectant, such as crude carbolic acid or other coal-tar preparation, $\frac{1}{2}$ gal.

Castor oil, 8 oz.

Stick of caustic potash or caustic soda.

Instruments:

Trocar and cannula.

Milk-fever outfit.

Drenching bottle (1 qt. bottle with long neck).

Clinical thermometer for cattle.

3. RENDERING FIRST AID

In many cases, the animal may be saved, or serious illness avoided, by the prompt application of simple remedies.

Procedure:

A. Observe animal closely to determine cause of illness.

B. If cause of ailment is apparent, give suitable first-aid treatment at once.

A. Observe animal closely to determine cause of illness.

Keep the animal under constant observation and note all the symptoms in order that you may determine, if possible, the cause of the illness. Often the first sign of illness is the failure of the animal to eat any or all of its feed. The animal may move very sluggishly, or less often may be excited and quick in its movements.

When an animal is in intense pain, it often stands or lies quietly in a drooping position with eyes sunken. Take the temperature of the animal by inserting a clinical thermometer in the rectum and leaving it there for three minutes. If the temperature is much above or below normal (101° to 102° F. in cattle), it is usually best to call a competent veterinarian. If the temperature is about normal and the animal does not seem to be in pain, apply the general treatment outlined below. Note whether there is any improvement or not. If the disease becomes worse, secure competent advice.

B. If cause of ailment is apparent, give suitable first aid treatment at once. As soon as the cause of illness is discovered, treat the animal at once. Delay may prove fatal.

4. GIVING GENERAL CARE TO SICK ANIMALS

Much can be done by the dairyman to relieve sick animals and give nature a chance to do its part. Following are some of the measures which should be taken:

Procedure:

- A. Reduce feed supply, and provide bulky, laxative feeds.
- B. Keep animal comfortable.
- C. Give laxative, if necessary.

A. Reduce feed supply, and provide bulky, laxative feeds. As soon as illness is noted, reduce the amount of feed given. Feed no concentrates and only half the usual amount of silage,



FIG. 120. CARE IS NEEDED IN DRENCHING A COW

The neck of the bottle is introduced into the side of the mouth and the liquid emptied on top of the tongue. Unless a person is experienced, it is best to have an assistant hold the animal's head.

together with a moderate amount of good-quality legume hay. Some fresh green grass or 15 to 20 pounds of sliced roots is also excellent at such times. Animals that are very sick, of course, will usually eat nothing.

B. Keep animal comfortable. It is best to blanket a sick animal in cold weather if the barn is cold or drafty. Use

plenty of dry bedding to keep the animal off cold floors. Warm the drinking water slightly. In hot weather, provide shade and keep off the flies by means of a fly repellent or darkening of the stable, or both.

C. Give laxative, if necessary. If the bowels are not moving freely, give the animal a drench of Epsom salts solution. The dose is about 1 to $1\frac{1}{4}$ pounds for each 1000 pounds live weight. Thus a Jersey cow weighing 700 to 800 pounds requires $\frac{3}{4}$ to 1 pound at a dose, while a Holstein cow requires $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds. Weigh out the salts and dissolve in 2 to 3 pints of hot water. Cool to about body temperature and pour into a long-necked bottle.

To give the drench, have a helper raise the animal's head by a halter. With the left hand, grasp the nostrils of the cow and insert the neck of the bottle into the side of the mouth so that it rests on the middle of the tongue. If the animal coughs, lower the head at once to prevent the liquid getting into the windpipe.

GENERAL INFORMATION

COMMON AILMENTS OF DAIRY CATTLE

The symptoms and treatment of each disease or ailment of dairy cattle differ from those of nearly every other. Some of the chief ailments affecting dairy cattle are briefly described below, together with suggestions for treatment.

If the caretaker is not experienced in treating sick animals, he should by all means secure competent advice whenever there is doubt as to the nature of the illness or the kind of treatment that should be given.

ABORTION

Nature. The birth of the fetus, or developing calf, before the full term. Abortions usually occur during the fifth, sixth, or seventh month, but may occur at any time during pregnancy.

Abortions are of two types: (a) noninfectious and (b) infectious. The latter is now commonly termed infectious abortion or Bang's disease and is discussed in the next section.

Causes of noninfectious type. This type of abortion, which is infrequent, may be caused by crowding in narrow doorways, striking of the abdomen by the head or horns of another cow, falling on wet, slippery floors, or in rare cases by rations extremely low in lime or other minerals.

Treatment. First determine the cause and remove it, if possible. If one or two animals are very troublesome in fighting it may be best to dehorn them, or if already dehorned, to keep them separate or to sell them.

BANG'S DISEASE

Nature. An infectious type of abortion which spreads rapidly from one animal to another.

Symptoms. Swelling of the udder and the external genital organs. Birth of calf before time, usually dead.

Treatment. No certain cure for abortion has yet been found. Treatment consists chiefly in prevention. Action must be taken at once after an abortion occurs, and constant care must be exercised to prevent the disease from spreading through the entire herd. Separate the aborting cow from cows that are not affected. Burn the dead calf, together with soiled bedding, afterbirth, etc. Clean and disinfect the stall where the cow has been, or, if the abortion has occurred at pasture, cover the spot with quicklime.

Until abortions cease and successive tests show the herd to be clean, follow the practice of isolating each cow from all other cattle, beginning about one week before calving and continuing for 3 to 4 weeks after calving or until all discharges cease. A cow is more likely to give off germs of the disease at calving than at any other time.

Usually it is best to dispose of aborting cows for slaughter, since there is great danger that they will spread infection and

the income from such animals is likely to be much less than from healthy ones.

The disease may be detected in affected animals by a test of their blood. The test is known as the agglutination test or, more commonly, the blood test. The milk may be tested also, for in some animals the udder is affected and germs are given off in the milk. Accurate tests can be made only by experienced persons. The test is very reliable except under abnormal conditions, such as immediately before and immediately after calving. There is sometimes an advantage, therefore, in having the test repeated in 30 to 60 days in the case of positively reacting animals which have shown no evidence of the disease.

The Federal Government in 1934 undertook a program for the eradication of Bang's disease. The plan followed is similar to that in the testing of herds for tuberculosis. Herd owners who sign agreements to cooperate in the program have their herds tested free of charge and are entitled to cash indemnities for diseased animals shipped for slaughter. The conducting of the test and the designation of positively reacting animals rests entirely with federal authorities.

Great care should be exercised in the purchase of animals to make sure that they come from disease-free herds or that they pass satisfactory tests before purchase. Unbred heifers are less likely to carry the disease than pregnant animals.

The feeding of rations extremely deficient in mineral matter rarely may cause abortion, but there is no evidence that the feeding of mineral supplements or mixtures of vitamins and minerals will prevent or cure Bang's disease.

Recent experimental work by the United States Department of Agriculture has shown that the vaccination of young, unbred heifers confers lifelong immunity to Bang's disease on the animals so treated. The results of the experiments are so promising that this method of combatting the disease may soon be made available for use by qualified state veterinarians.

BLOAT

Nature. A greatly enlarged barrel, especially in the region of the upper left flank.

Cause. The rapid formation of gas in the paunch, or first part of the stomach. This is sometimes caused by indigestion or by the eating of young clover or legumes at the beginning of the season, particularly if the plants are wet from dew or rain. This ailment may follow the eating of fresh beet pulp, frozen roots, pasture grass covered with frost, or spoiled feed of any kind.

Symptoms. Swelling of the barrel with marked enlargement in the region of the upper left flank. The hide may be stretched so tightly that striking the animal with the fingers at this point gives a sound like that of a drum. The animal appears to be in pain, has difficulty in breathing, and, if not given relief very soon, may die of suffocation.

Treatment. In mild cases, forcing the animal to walk quickly for fifteen minutes may bring relief. A leather halter may be placed on the head and a smooth piece of wood, such as a section of a broomstick 6 to 8 inches long, may be placed in the mouth and attached to the halter as a bit, by means of holes bored through the ends. This causes movements of the tongue and swallowing, permitting some of the gas to escape by way of the mouth.

Medicine may be given as a drench. Two ounces of aromatic spirits of ammonia in a quart of cold water every half hour, or $1\frac{1}{2}$ ounce of formalin in 1 quart of water, or 1 to 2 ounces of turpentine in 1 quart of milk or linseed oil are suitable for this purpose.

In severe cases, treatment must be prompt. At a spot on the left side equally distant from the hip bone, last rib, and backbone, make a cut in the skin about $\frac{3}{4}$ inch long and insert a trocar and cannula. Withdraw the trocar and allow the gas to escape through the cannula. The cannula may need to be

left in for several hours. After removing the cannula treat the wound with tincture of iodine. Give a dose of Epsom salts after a severe attack of bloat, and provide a small amount of laxative feeds for a few days.

Giving animals a full feed of hay, silage, and grain, or hay alone, before turning them to pasture the first time in the season, helps to prevent bloat. A supply of straw in a rack should be provided for cows on legume pasture. Cattle should be kept from pastures when frost is on them, and should not be allowed to pasture on legumes for several hours after heavy frost has disappeared from the plants.

COWPOX

Nature. Small lumps, containing yellow pus, on teats. Bad sores develop if lumps are rubbed off by the hand.

Cause. An infectious organism, usually carried from cow to cow on the hands of the milker.

Symptoms. In four to seven days after a cow is infected, the temperature rises, the udder becomes red, little hard lumps appear on the teats and udder, and the milk flow is reduced. The lumps have a blister-like appearance at the top and contain a yellow pus. They disappear in sixteen to twenty days.

Treatment. Isolate the cow. Milk her the last of the herd. If there are open sores, the milk should not be used, as the disease may be contracted by man. If teats are very sore, use milking tubes to remove the milk.

Bathe the udder twice a day with a solution made by dissolving 1 ounce of granular hyposulphite of soda in 1 quart of warm water. The milker should also use this solution for washing his hands after milking infected cows. Rub on the lumps or sores an ointment such as carbolated vaseline, benzoated oxide of zinc, or 1 part boric acid to 7 parts balsam of Peru. In obstinate cases, paint the sores once daily with a 2 per cent solution of mercurochrome.

FOOT ROT

Nature. Soreness between the claws. In advanced cases, pus forms.

Cause. At first, soreness due to gravel, cinders, or manure lodging between the claws. Later, infection may set in. Cattle walking through deep mud, or pastured on swampy ground, are subject to it.

Symptoms. A limping gait; heat and swelling above the hoof; pus and foul odor.

Treatment. Cleanse the parts thoroughly each day with a disinfectant solution, such as 1 ounce of carbolic acid to 1 pint of water. If sloughing has taken place, fasten a wad of oakum or cotton smeared with pine tar between the claws, by means of strips of cloth.

Another simple and effective treatment is to place the affected foot in a bucket containing a saturated solution of potassium permanganate.

IMPACTION

Nature. Too free feeding on dry feed, or, occasionally, the eating of materials such as wood, cloth, or weeds. A hard pack of dry feed lodges in one or more parts of the stomach.

Cause. This trouble most frequently occurs among cows that are being fed for high-production records or among those that have obtained access to grain bins.

Symptoms. The cow fails to eat and produces much less milk than usual. Enlargement occurs in upper left flank, which feels hard or doughy to the touch. The cow stands with back arched, or lies on the right side. There may be heavy, rapid breathing and some bloating.

Treatment. Give no feed for twenty-four hours or more. Give a drench of 1 to 2 ounces of aromatic spirits of ammonia in 1 quart of milk or water, and later a drench of Epsom salts in 4 quarts of water to which has been added 2 ounces of ginger. Give lukewarm water to drink. Inject 1 to 2 gallons

of warm water into the rectum by means of force pump and smooth rubber hose, to move the bowels.

As a last resort, a skilled veterinarian may remove the contents of the stomach through an opening made in the flank.

As a preventive of impaction in animals being fed heavily, moisten the concentrates before feeding.

LICE

Nature. Several kinds of lice, usually of a dull white color, attack the skin of the animal, first in the regions of the head, neck, and tailhead, and later on any part of the body. The lice attach their eggs, or nits, to the hair of the cattle, where they may be seen as small white bodies.

Symptoms. Intense itching of the skin. The affected animal will be rubbing on posts, gates, etc. In advanced cases, the hair may fall out.

Treatment. Bathe the animal with a coal-tar preparation, such as creolin, zenoleum, etc., used at the rate of 1 part to 50 parts of water. Repeat in one week to destroy lice that have hatched in the meantime. In cold weather, provide a warm place for bathing the animal, use warm water, and blanket the animal until dry. Unless these precautions can be taken, it is best not to bathe animals in cold weather but to dust an insect powder lightly on the affected parts.

If the buildings and lots are badly infested, it is useless to treat the animals unless these are treated also. Clean thoroughly, and spray with kerosene or one of the common disinfectant solutions.

LUMPY JAW

Nature. A disease causing a swelling on the jaw or head.

Cause and symptoms. A fungus, taken into the mouth on the feed, enters the jaw bone or the tissues near it, producing a hard lump which later may break and discharge pus.

Treatment. It is best to secure the advice of a veterinarian. If free from the bone, the lump may be removed in the early

stages by the knife, the wound being treated with antiseptics. If the bone is affected, treatment consists in giving potassium iodide solution as a drench, the dose being $\frac{1}{8}$ to $\frac{3}{8}$ ounce daily in a half pint of water. At the end of a week or ten days, when the eyes and nose discharge mucus and the skin becomes scurvy, the medicine should be discontinued. The lump usually disappears slowly. Care should be taken that the other animals do not come in contact with an infected animal having a discharge. Provide laxative feeds.

MILK FEVER

Nature. A disease affecting high-producing cows shortly after calving. The affected animal becomes unconscious and dies within a few hours if not treated.

Cause. The essential cause of milk fever is an acute calcium deficiency.

Symptoms. The disease usually occurs within two days after calving. The cow is restless and may thrash about wildly. After a time paralysis of the hind legs sets in, resulting first in an unsteady gait and finally in inability to rise. The cow lies with her head turned close to one side.

Treatment. The treatment is very simple and, if given in time, effects a cure in a few hours in nearly every case.

Inflate the udder with air by means of a milk-fever apparatus or with compressed oxygen. Before using the apparatus, boil the milk tube for fifteen minutes or more and place fresh absorbent cotton in the cylinder. Wash the ends of the teats and the operator's hands in a disinfectant solution, and dip the milk tube of the apparatus in the solution also. Insert the milk tube into the teats, inflating each quarter in turn. If necessary, tie a wide strip of soft cloth lightly about the teat after inflation to prevent the escape of air. If bandages are tied around the teat after inflation of the udder, they should be loosened every 3 to 4 hours to prevent necrosis or death of the tissue below the ligature. The udder should re-

main inflated for twenty-four hours or more. If the air escapes during this time, reinflate.

Another simple and effective treatment which, however, is best applied by a veterinarian, is to inject into the circulation a solution of calcium, usually calcium gluconate.

Do not milk the cow nor allow the calf to nurse while the cow is affected. Do not attempt to give medicine as it may choke the cow. Recovery usually occurs in twelve to twenty-four hours after treatment. Follow recovery with laxative feeds.

As a precaution against the occurrence of milk fever, during the first two days after calving remove only enough of the milk from the udder to relieve the pressure.

PINK EYE

Nature. A contagious disease causing inflammation of the eyes.

Cause. A germ which may be transmitted from one animal to another.

Symptoms. Intense inflammation of the membranes about the eyes, with a discharge which runs down over the face; swelling of the eyelids; closing of the eyes and partial blindness for a time. General symptoms are loss of appetite and reduced milk production.

Treatment. House in cool, dark stable separate from other animals. Give a drench of Epsom salts. Wash the eyes several times a day with a solution of boric acid made by dissolving 4 drams ($1\frac{1}{2}$ ounce) of boric acid in 16 ounces of boiling water and allowing to cool. If the treatment is given in time, the inflammation usually disappears in ten to fourteen days.

PNEUMONIA OF CALVES

Nature. Inflammation of lungs with difficult breathing and frequent coughing.

Cause. Exposure, a specific infection, or a complication of diseases.

Symptoms. The first symptoms noted are dullness, coughing, and rapid shallow breathing. The temperature is elevated, the calf has a poor appetite, a rough coat, and loses flesh rapidly.

Prevention and treatment. Consult a competent veterinarian. Prevent the chilling and exposure of all calves. Early removal from damp, cold quarters is beneficial. Blanket the calves and keep them warm and comfortable. Isolate all sick animals if possible. Careful nursing and good care are necessary for recovery.

RETENTION OF AFTERBIRTH

Nature. The membranes surrounding the fetus are not expelled after calving. If allowed to remain, they decompose, causing poisoning of the entire system and resulting in decreased milk production and often failure to breed.

Cause. This is a very common occurrence in dairy cows, and is due to a variety of causes. Improper feed, such as an insufficient amount of feed, lack of minerals, moldy or spoiled feed, or overfeeding accompanied by constipation, may induce it. Drinking ice water or eating cold feed at the time of calving, chills, nursing of the calf, or milking too soon after calving may also be causes. This trouble usually accompanies abortion.

Symptoms. If some of the membranes hang from the cow, the afterbirth is being retained. When retained, the membranes decompose, giving rise to a discharge having a very foul odor.

Treatment. When due to the cow's being in poor condition or to chills, give a hot bran mash, a drench of Epsom salts to which has been added 1 ounce of ginger or half an ounce of black pepper, or hot drinks. If not expelled within twenty-four hours after calving, the afterbirth should be removed by

hand. For this work only a veterinarian or other experienced person should be employed, for injury to the organs may cause infection leading to fatal results.

RINGWORM

Nature. Circular patches on the skin, from which the hair falls out, and on which scale crusts form. Occurs in winter or spring. May be contracted by man.

Cause. A vegetable parasite.

Symptoms. Small inflamed areas at first, usually on head or neck, later followed by slight discharges which form a scaly crust. The hair falls out from the affected areas. These areas may spread over a large part of the body. There is some itching of the affected parts.

Treatment. Remove the crusts by washing with soap and water, then paint over the affected areas once daily for several days with tincture of iodine, sulphur ointment, or a solution of 1 part of carbolic acid to 20 parts of oil. Bathing the areas with a solution made by dissolving 2 ounces of copper sulphate in 1 gallon of boiling water has also been recommended.

It is well to disinfect the stable and whitewash it.

SCOURS, COMMON

Nature. Looseness of the bowels of calves.

Cause. Too large amounts of milk; irregularity in amounts or temperature of milk or time of feeding; feeding milk too rich in fat; feeding sour or dirty milk; the use of dirty pails.

Symptoms. Loose or liquid discharge from the bowels; loss of appetite; gaunt appearance of the body.

Treatment. Reduce the amount of milk fed to one-half. Mix $1\frac{1}{2}$ ounce of formalin in a pint of water and add a teaspoonful of the mixture to each pint of milk fed for two or three days. Feed the usual amount of milk again as soon as improvement is noted. In mild cases, scalding the milk and

then cooling to body temperature before feeding may correct the trouble.

In severe cases, give a physic of 2 ounces of castor oil in a pint of milk; and give in the milk, or place on the tongue two or three times daily, 1 teaspoonful of a powder consisting of 1 part salol and 2 parts subnitrate of bismuth. In addition, 8 ounces to 1 pint of lime water may be added to the milk at each feeding as a corrective.

SCOURS, WHITE

Nature. Looseness of the bowels of calves, marked by a frequent discharge of nearly liquid dung which is dirty-white in color and has a very foul odor.

Cause. An infectious organism which gains entrance through the mouth or raw navel of the calf.

Symptoms. The nature of the discharge from the bowels is the most characteristic symptom. The course of the disease is very rapid; in a few hours the calf becomes too weak to stand, and it may die in one or two days.

Prevention and Treatment. To help the calf in resisting infections of all kinds, it should have some of its mother's first or colostrum milk. The udder and teats should be washed with a disinfectant solution before the calf is permitted to nurse. If cases have occurred in the herd previously, care must be taken to clean and disinfect thoroughly the stalls in which calves are born. Burn or bury the bodies of all calves that die of the disease, and burn all the litter in the stalls. Treat the navel of the calf at birth with tincture of iodine.

The injection of white-scours serum into the circulation soon after birth is a good preventive and may be used also when the first symptoms are noted. This treatment is expensive, however, and is justified only if the calves are valuable. Another kind of serum may be used in prolonged cases.

TEATS, CHAPPED

Nature. Roughness of the skin on the teats, which develops into sores.

Cause. Exposure to cold winds, especially if teats have been wet in milking or by damp bedding.

Treatment. Soak in hot boric acid solution and rub dry. After each milking, apply carbolized vaseline or medicated salves sold for this purpose. If teats are very sore, a little of the salve placed on the palms of the hands before milking helps reduce the irritation.

TEATS, SORES AND SCABS OF

Nature. Sores or scabs on ends of the teats, which make milking difficult.

Cause. Injury by long fingernails, milking with wet hands, or dirty floors.

Treatment. Soak in hot, saturated boric acid solution twice each day. Every other day, paint with tincture of iodine, or in bad cases use a mixture consisting of 1 part borax to 7 parts balsam of Peru.

TEATS, WOUNDS

Nature. Wounds caused by tearing the teats on wire fences or by cows stepping on them, etc.

Treatment. Treat at once with hot boric acid solution. Apply a disinfectant dusting powder, which may be purchased, at drug stores, in sifter-top cans, or may be made up as follows:

- 1 part iodoform,
- 1 part tannic acid,
- 4 parts boric acid.

If the teat is so badly torn that it can not be milked, disinfect a milking tube and insert it. Hold it in place by wrapping adhesive tape not too tightly about it. Usually the tape

may be removed in about ten days. If the udder becomes hot, infection has set in. In this case, remove the tape and apply benzoated oxide of zinc ointment.

TUBERCULOSIS

Nature. A disease affecting the lungs or almost any of the organs or tissues of the body.

Cause. A specific germ which may be transmitted from animal to animal. Young animals may be infected by drinking milk from cows having infected udders.

Symptoms. There are usually no outward symptoms until the disease is in its most advanced stages.

Treatment. There is no known cure for the disease. The only certain method of finding whether or not the animals in the herd are affected is to have a competent veterinarian apply the tuberculin test.

The Federal Government conducts tuberculin tests for all herds of cattle and provides for the removal and slaughter of all animals which react positively. As a result of this extensive program which was begun in 1917, the amount of infection has been reduced to a very low point. Simultaneously with the reduction of tuberculosis in cattle herds, the number of cases of tuberculosis in children has shown a very great decrease.

As a preventive against introducing disease into the herd, any milk or whey purchased from a creamery or cheese factory for feeding should be thoroughly pasteurized before being used. Furthermore, animals should be purchased only after having passed a tuberculin test and should be purchased subject to a retest made within sixty to ninety days.

UDDER, CAKED OR INFLAMED

Nature. The udders of good dairy cows that are in high condition of flesh usually become inflamed and tender at calving. In severe cases, the udder pits on pressure.

Treatment. Feed very lightly on concentrates until the inflammation disappears. Give laxative feeds, such as bran, roots, and alfalfa hay. The most effective treatment is milking three or four times daily, followed by thorough massaging of the udder with the hands in an upward and backward direction for ten or fifteen minutes each time. Unsalted lard, camphorated oil, or cottonseed oil may be rubbed in, to help reduce



FIG. 121. MASTITIS REQUIRES PROMPT TREATMENT

This waterproof canvas bag, made especially for the purpose, is strapped over the loin and hips. It is kept filled with hot water until inflammation subsides.

the swelling. The application of hot packs is also helpful in reducing congestion of the udder.

UDDER, INFECTION OF, OR MASTITIS

Nature. Inflammation of the udder, accompanied by an infection which changes the composition and appearance of the milk.

Cause. An infectious organism. Indirect causes are lying on cold floors, cold drafts, or injury.

Symptoms. Hardening of the udder, with inflamed appearance; lumps above the teats; thick stringy milk; high fever;

loss of appetite. If not treated, the disease often results in the loss of one or more quarters of the udder.

Prevention. The practice of strict sanitation in the stable is effective in preventing mastitis. Do not milk affected quarters on the stable floor. Adequate stall space should be provided to prevent the injury of the udder. The floor should be well bedded and dry at all times. Affected animals should be separated or placed at the end of the milking line and milked last. The hands of the milker should be thoroughly disinfected after milking an infected cow. The milk of all cows that are being considered for addition to the herd should be tested for mastitis.

Treatment. It is best to consult a veterinarian. Treatment must be given at once. It consists in giving the cow a physic of Epson salts and reducing the protein content of the ration. Pass a sheet around the udder and body of the cow to support the udder, cutting holes for the teats. Pack soft rags around the udder. Pour water, as hot as the hand can bear, on the rags every ten to fifteen minutes. After two hours of this treatment, dry the udder and rub on a salve made of 1 part of mercurial ointment and 3 parts lanolin. Use this treatment twice a day. Milk out all affected quarters every hour.

Vaccination for the prevention and treatment of mastitis is of little value.

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CHAPTER XVII

KEEPING BUSINESS ACCOUNTS WITH THE DAIRY HERD

The production of milk or cream for the market requires the use of good business principles if it is to be financially successful. Too often, no accounts of the cost of maintaining the dairy herd are kept. If a good living is secured from the farm business as a whole, it is supposed that the dairy herd is making a profit. There are many instances in which it would be more profitable to dispose of the herd and sell the farm crops than to continue to maintain the herd under existing conditions. A system of accounts, even though very simple, must be kept to determine whether or not the dairy herd is a profitable part of the farm business.

Operations:

1. Taking an inventory.
2. Keeping feed records.
3. Keeping records of purchases and miscellaneous expenses.
4. Keeping records of income from herd.
5. Calculating profit and loss.
6. Analyzing results of year's business.

1. TAKING AN INVENTORY

An annual inventory makes it possible to give credit to the herd for increases in the number or value of animals in the herd during the year. It is also a means of determining whether receipts from the sale of cattle are real returns from the growth of the herd or whether such sales have resulted in decreasing the value of the herd.

Procedure:

A. Provide permanent record book.

B. Make an itemized list of property at beginning of each year.

A. Provide permanent record book. Secure a bound record book for keeping the inventory and other business accounts of the herd. This may have only heavy paper covers, but the leaves should be bound together substantially so that it may be kept intact over a series of years.

B. Make itemized list of property at beginning of each year. Make a list of all animals and equipment pertaining to the dairy herd, together with their values. Such a list is called an inventory. It should be made at the beginning of each calendar year (January 1) or annually at some convenient time, which is often March 1, in the case of tenant farms. For convenience, the inventory taken at the beginning of any calendar year is termed the opening inventory, and that taken at the end of the year, the closing inventory.

List each animal by herd number or name, and note its age and value. The values of the animals may be determined by several different methods. One is to compare your own animals with those sold at public sales. Another is to have two or three neighbors, who are familiar with prices of dairy cattle, come to the farm and set prices on the animals. Occasionally the services of a stock dealer may be secured. The milk records of the cows should be used, of course, in arriving at the value of the cows and their calves. The values of the calves are largely determined by the milk records of their mothers.

It is essential that the age of each animal be listed, for calves and heifers normally increase in value materially for a few years, while the older cows decrease in value with age.

Include in the inventory, also, the value of the buildings, or parts of buildings and water systems, used for the herd, milk house, and special dairy equipment, such as milking machines, cream separators, cans, pails, strainers, and tools.

OPENING INVENTORY

OAK LAWN FARM DAIRY HERD

January 1, 1940

Cows:

Blackie.....	7 years old.....	\$115.00
Spot.....	5 years old.....	165.00
Beauty.....	6 years old.....	130.00
Beauty II.....	4 years old.....	160.00
Nellie.....	9 years old.....	100.00
Dora.....	4 years old.....	155.00
Whitey.....	4 years old.....	145.00
Maud.....	3 years old.....	160.00
Hazel.....	3 years old.....	150.00
Flora.....	3 years old.....	170.00
Bertha.....	2 years old.....	120.00
Joan.....	2 years old.....	140.00

Heifers and herd sire:

6 yearlings @ \$65.....	390.00
5 heifer calves @ \$30.....	150.00
Herd sire.....	150.00

Buildings and land:

Dairy barn, fences, and milk house.....	2800.00
Land in exercising lots.....	120.00

Equipment:

Cream separator.....	80.00
Milking machine.....	85.00
12 milk cans, 4 milk pails, 2 strainers, 8 calf pails.....	30.00
Litter carrier.....	65.00
Feed cart.....	20.00
Halters, blankets, forks, shovels, milk cart, etc.....	45.00

Total.....	<u>\$5645.00</u>
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2. KEEPING FEED RECORDS

One of the largest sources of loss and the most important reason for lack of profits in keeping a dairy herd is the failure to feed cows in proportion to their needs. The keeping of a daily record of the production of the individual cows makes it

possible to give to each cow the exact amount of feed needed; and if a record is also kept of the feed given to each cow, it can readily be determined not only whether the herd as a whole is making a good profit but also which of the cows are making the best profit and which may be causing an actual loss.

Procedure:

- A. Secure or make feed-record blanks.
- B. Determine amount of feed given animals daily.
- C. Secure prices of feeds for month.
- D. Calculate cost of feed for each cow for month.
- E. Summarize records for the year.

Equipment:

Feed-record blanks, board, thumb tacks, two sheets of celluloid, large basket, washtub or box, platform scales or circular spring balance.

A. Secure or make feed-record blanks. Secure a supply of feed-record blanks from some firm having them for sale (see references at end of chapter), or make some of your own by ruling sheets of heavy paper as shown in Fig. 122. The sheet for the current month may be kept in a glass case especially designed for the purpose, or it may be fastened to a board by means of thumb tacks. If the latter method is used, the record sheet may be protected from being soiled by the hands or flies, by using two pieces of transparent celluloid in the same way as explained for the milk-production record. Each piece should be about half the height of the record sheet and about 2 inches wider. These pieces are thumb-tacked to the board in such a manner that they are just wide enough apart to expose one day's space on the record blank.

B. Determine amount of feed given animals daily. It is essential that the concentrates for each cow be weighed at each feeding, as explained in Chapter VIII. This, of course, necessitates a feeding chart or guide kept conveniently near the

weight balance. This chart may be a temporary sheet attached to the feed chart, or it may be the regular monthly feed sheet. If a temporary sheet is used, copy the amounts from it to the monthly record.

Month _____		FEED RECORD											
Cow No.		1			2			3			4		
Day of Month		Silage	Grain	Hay	Silage	Grain	Hay	Silage	Grain	Hay	Silage	Grain	Hay
1	A.M.												
	P.M.												
2	A.M.												
	P.M.												
3	A.M.												
	P.M.												
4	A.M.												
	P.M.												

FIG. 122. PORTION OF A FEED-RECORD SHEET

The sheet may be extended to provide space for records for the entire month and for fifteen cows or more. A space should be provided at the bottom of the sheet where the kind of grain mixture used may be indicated.

Make note at the bottom of each monthly record sheet of the kind of grain mixture used. If this is a ready-mixed feed, give the brand and cost per ton. If a home-mixed feed is used, write down the number of pounds of each feed used in making the mixture. Note also the cost of any of these feeds which have been purchased.

If hay is not weighed regularly, weigh the amount fed each cow during one day and use this as the average daily amount for the month. To weigh the hay, place a large basket, wash-tub, or box on a platform scale; if the scale has a double beam, use the weight on one of the beams to balance the basket, tub, or box. Then use the other beam for weighing the hay for each cow. In case a considerable portion of the hay fed remains uneaten, it should be weighed back and the weight recorded. Silage may be weighed in the same manner as the hay, preferably in a galvanized iron bushel basket.

In case no platform scale is available, a circular spring balance having a capacity of 60 pounds, such as the type used for weighing milk, may be used for weighing hay and silage. When such a balance is used, roll the hay into a bundle, tie with binder twine or cord, and hang on the scale hook. To weigh the silage, tie a small rope from handle to handle of the basket, leaving a little slack, and suspend the basket by slipping the rope into the scale hook. Be sure to deduct the weight of the empty basket from the weight shown on the scale, or set one of the scale hands to read zero when the empty basket hangs on the scale.

Keep account also of the feed consumed by the yearling heifers, calves, and herd bull. For the sake of economy and accuracy in feeding, make daily weighings of the concentrates fed each of the yearlings and the herd bull, together with the total amount of concentrates fed to calves. Determine the amounts of roughages fed the young stock and herd bull by the same procedure followed for the cows.

C. Secure prices of feeds for month. Use the purchase price of feeds bought when calculating the cost of feed for the month as directed below, but in the case of feeds raised, consult the local feed dealer or elevator manager in regard to prices of grain and hay for the month. In case the prices can not be obtained in this manner, they may be secured from farm papers or from one of the publications listed in the references at the end of this chapter. If the latter plan is followed and

prices at the large central markets are the only ones available, make allowance by subtracting from these central market prices the cost of getting crops to them.

Feeds purchased ready ground or mixed, will, of course, be charged at the price paid, but if feeds are ground on the farm the local custom rate for grinding should be added to the price



FIG. 123. UNLESS ACCOUNTS WERE KEPT, COWS LIKE THIS ONE WOULD NOT BE DISCOVERED

Illini Nellie makes good use of an hour's freedom on an April morning in a pasture of winter rye. Pasture like this furnishes vitamins which keep cows in good health and condition. The pasture grass is so high in water content, however, that it alone will not support a production as great as that of this famous cow, which equaled 81 pounds of milk daily and 100 pounds of butterfat a month for an entire year.

of the feeds. On some farms hays and fodder are ground. A fair estimate of the cost of this operation, provided there are no local custom rates which can be applied, is \$2.50 to \$3 per ton.

Corn silage is a perishable product, which must be fed near the place where it is produced. There is, therefore, no price

for it based upon demand and supply on the market. A price, which represents very closely its value compared with that of other feeds, may be calculated as follows:

Find the value of 4.6 bushels of shelled corn at local market price, less the cost of marketing.

Find the value of 270 pounds of mixed hay at the local market price, less the cost of marketing.

The sum of the two above values represents the farm value of one ton of corn silage.

The value of pasture is rated at \$1.50 to \$3 per month per cow, and at one-half as much per head of young stock. The value varies greatly, depending upon the price of other feeds, quality of the pasture, and the price being received for dairy products. Cornstalk pasture is rated at \$1 to \$2 per acre.

D. Calculate cost of feed for each cow for month. Multiply by their respective prices the amounts of the various feeds consumed during the month by each cow in the herd. Add the costs for the different feeds, to obtain the total feed cost for the month for each cow. Include also the value of straw, or other material used for bedding, that is produced on the farm.

E. Summarize records for the year. Copy from the twelve monthly feed sheets the cost of feed for each month, and total the items. These totals should be entered on a separate summary sheet.

3. KEEPING RECORDS OF PURCHASES AND MISCELLANEOUS EXPENSES

Every expense incurred in connection with the herd should be promptly and accurately recorded in order that the true cost of production may be determined.

Procedure:

A. Record purchases of livestock.

B. Record labor and miscellaneous expenses.

A. Record purchases of livestock. Whenever an animal is purchased, record the date of purchase, name of seller, name and herd number of the animal, age, and price paid, plus any transportation charges. The names or numbers of such animals and their total cost should be added to the inventory taken at the beginning of the year.

B. Record labor and miscellaneous expenses. Estimate the amount and value of labor expended on the care of the herd each month. When hired labor is used for both the care of the herd and other farm work, estimate the proportion of the workers' time spent in caring for the herd, and charge the herd with a proportionate part of the wages paid. Estimate also the value of family labor which is not paid in cash.

Charge the herd with the use of buildings, tools and equipment at the rate of 3 per cent of the value of the buildings and 10 per cent of the value of the equipment actually used in connection with the herd. This represents the depreciation of the buildings and equipment.

Record also miscellaneous expenses, such as medicine, veterinary fees, registration fees, insurance, and taxes on cows.

4. KEEPING RECORDS OF INCOME FROM HERD

Similarly all receipts from the sale of dairy products, livestock, etc., and the value of all dairy products consumed on the farm or in the home, should be carefully recorded.

Procedure:

- A. Arrange suitable record book.
- B. Keep record of dairy products used at home.
- C. List each sale of dairy products.
- D. List each sale of livestock.
- E. Record miscellaneous receipts.

A. Arrange suitable record book. Arrange a page in your record book for entries of the sales of milk and cream. Rule

the page vertically, providing columns for the date, farm to which sale was made, amount of milk or cream, the test, price, and total amount of sale. Arrange another page, headed "Milk and Cream Used at Home," for entries of the amount of milk and cream used by the family each week or month, using column headings similar to those given above. Provide a third page, headed "Milk Fed," with columns showing date, whole milk, skim milk, amount, value per hundredweight, and total value. Set aside another page for sales of livestock and one for miscellaneous items.

B. Keep record of dairy products used at home. Provide a sheet in the barn for keeping account of the amount of milk and cream taken to the house for family use, or sold to the hired help, and of the amount of milk fed to livestock other than calves. Columns for these entries may be made on the milk-record sheet on which the daily milk records of each cow are kept, or on a separate sheet ruled for the purpose.

Weigh or measure the amount of milk and cream used by the family and hired help, and record the amount. If it is not possible to do this each day, make the measurement one day each week and from this estimate the amounts used weekly. If the milk and cream are measured in quarts, the amounts may be converted to pounds by multiplying the number of quarts by 2.15.

Weigh or measure the amount of milk fed to livestock other than calves. Do not include in this record any milk that is obtained from cows during the first eight milkings after calving, as such milk is not considered fit for sale.

When the cream is separated and the skim milk fed to pigs, the skim milk may be weighed after separating and the amount recorded. In case a platform scale for weighing is not available, the amount of skim milk may be estimated from the weight of the whole milk, assuming that the skim milk forms 80 per cent of the whole milk. The weight of the whole milk may be estimated, in turn, by totaling the individual milk yields of the cows and assuming that each gallon weighs 8.6

pounds, or each 8-gallon can contains 69 pounds and each 10-gallon can 86 pounds.

When cream is churned on the farm and the buttermilk fed to livestock, the weight of the buttermilk may be estimated as 65 per cent of the weight of the cream churned.



FIG. 124. HEADED FOR PASTURE IN THE COOL PART OF A JULY DAY

On hot summer days cows make their best use of pastures mornings and evenings. It is therefore good management practice to provide shade for the hottest hours of the day and to permit pasturing over-night.

C. List each sale of dairy products. Each time that a check or cash is received from a sale of milk, cream, butter, or other dairy products, make an entry of it in your record book, being careful to include the test of milk or cream if payment is made upon a butterfat basis. In making this entry, record only the net amounts received for the product after deducting hauling or other marketing costs. Total the amounts received during each month.

From the barn records, compute the total amounts of milk, cream, and skim milk used for food or fed to livestock other than calves during the month. The milk and cream should be valued at the average price received for the milk and cream

sold during the month, basing the charge upon the net amount received for 100 pounds of milk or one pound of butterfat after deducting hauling and other marketing costs, if any.

The value of skim milk may be estimated in different ways. If there is a market for both whole milk and butterfat, the

value of the skim milk may be estimated as the difference between the market value of 100 pounds of whole milk and the value of the butterfat in 100 pounds of milk. For example, if whole milk is selling for \$2.25 per hundredweight and butterfat for 48 cents per pound, milk testing 3.5 per cent fat would be valued at \$1.68 on the butterfat basis ($3.5 \times \$.48 = \$1.68$), and the difference between \$2.25 and \$1.68, or \$.57, would be the value of the skim milk (80 pounds) derived from 100 pounds of whole milk. The value of the skim milk per hundredweight would be $\frac{\$.57}{.80} = \$.71$.

In the absence of a market for whole milk, the value of skim milk per hundred pounds may be estimated as one-half the market price of corn per bushel.

D. List each sale of livestock. Record each sale of an animal from the herd, including the date, name or herd number of the animal, the name of the purchaser, and the selling price. Unnamed calves may be designated by using the name of the calf's mother, followed by the letter *s* or *d* (son or daughter), depending upon the sex of the calf.

E. Record miscellaneous receipts. Make entries of sales of miscellaneous nature, such as hides, bull services, etc.

Compute the amount of credit due to the herd for manure produced, and list this as one of the receipts. To calculate the value of the manure, determine the average number of animals over two years of age, and the number under two years, in the herd during the year. Credit each animal over two years of age with 12 tons of manure valued at \$.75 to \$2.50 per ton (\$1.50 being a fair estimate) and the animals less than two years of age with one-half that amount.

Another method of arriving at the value of the manure is to keep account of the number of loads of manure produced by the dairy herd during the year. The loads may be valued at \$.75 to \$2.50 each, \$1 being a figure in common use.

5. CALCULATING PROFIT AND LOSS

It is customary on many dairy farms to attempt to determine whether or not the herd is profitable by comparing the cost of the feed given each cow with the value of the milk she produces. Such a method gives valuable information, since the cost of feed usually forms 50 to 55 per cent of the total cost of milk production. It has the advantage of indicating the relative profitableness of each cow, but does not take into con-



FIG. 125. COWS CAN NOT OBTAIN SUFFICIENT FEED FROM A PASTURE LIKE THIS

Cows like those pictured here are capable of producing large amounts of milk when supplied with ample amounts of high-quality feeds. Supplementary feeding is indicated under conditions like those shown here.

sideration increases or decreases in the value of the herd and the cost of labor, which may be large items.

More complete methods are outlined below. They are not so detailed as most cost accounting methods, but may be used with approximate accuracy.

Procedure:

- A. Prepare statement of business for the year.
- B. Determine increase or decrease in value of dairy herd.

- C. List total receipts and credits.
- D. Itemize expenses.
- E. Compute returns.

A. Prepare statement of business for the year. Prepare summary sheets with columns for receipts and expenses.

Besides the feed summary sheet already mentioned, another page should be used for summarizing the sales of dairy products, one for the purchases and sales of cattle, and one for labor and miscellaneous expenses. Then, too, the inventory totals for the beginning and close of the year must be readily available.

B. Determine increase or decrease in value of dairy herd. When summarizing the year's business, the value of any dairy animals purchased during the year should be added to the opening inventory at their original cost. The closing inventory should include the numbers and values of all dairy stock *on hand* at the end of the year, including all stock raised or purchased during the year. The values used should be the actual values at the end of the year. The values of old cows may be less at the end of the year than at the beginning and the values of young cows or heifers are usually greater. Add the amounts of dairy cattle sales made during the year to the value of the dairy stock in the closing inventory.

If the sum of the values of the stock in the dairy herd as listed in the closing inventory plus the sales of dairy stock during the year is greater than the sum of dairy stock values as listed in the opening inventory plus purchases during the year, an increase in the value of the dairy herd is thus shown. Place the amount of the increase in the receipt column of the summary, but if there has been a decrease, list the amount as an expense.

C. List total receipts and credits. List the total receipts from sales, the value of the dairy products used by the family and help, and the value of milk fed to livestock other than calves.

D. Itemize expenses. List all the expenses for feed, labor, etc., that have been paid in cash, as well as the value of feed, including pasture, raised on the farm and consumed by the herd, bedding, family labor, depreciation of buildings and equipment, etc.

E. Compute returns. There are several different methods by which the returns may be computed. A valuable index of dairy efficiency has been found to be the income from \$100 worth of feed fed. This is readily calculated by comparing the receipts from the sale of dairy products, dairy cattle and miscellaneous items, together with the increased value of the dairy herd during the year (if any), with the cost of feed.

$$\frac{\text{Total receipts}}{\text{Value of feed fed}} \times 100 = \text{Income per \$100 worth of feed fed}$$

This method is readily applied in the case of the General Summary of the Oak Lawn Farm Dairy Herd shown herewith. The receipts are shown to be \$3003.85 and the total value of feed and bedding \$1475. Dividing the first amount by the second and multiplying by 100 gives \$204, the returns from \$100 worth of feed fed.

Another method is to compute the difference between the total receipts from all sources and all the expenses except the manager's labor. The difference represents the returns to the owner or manager for his labor and management.

Again using the General Summary shown above as an example, it is found that the difference between the total receipts and total expenses is \$304.82. A charge of \$400 for the labor of the manager is listed as one of the expenses. If this charge of \$400 for the manager were not made, there would be left a net return of \$304.82 plus \$400, or \$704.82, to the manager or operator for his labor and management in connection with the dairy herd. If the family labor is also considered on the same basis, then the returns to the manager and his family for labor and management are \$754.82.

A third method is to figure the returns on the money invested

GENERAL SUMMARY
OAK LAWN FARM DAIRY HERD
Year Ended December 31, 1940

Receipts

Increase in dairy herd values (closing inventory plus sales) less (opening inventory plus purchases).....	\$739.75
3940 pounds butterfat sold.....	1773.00
912 quarts milk used by family @ .5 cents.....	45.60
63,000 pounds skim milk fed to hogs @ 25 cents per cwt.....	157.50
Manure from 12 cows and 1 bull @ \$18 each.....	234.00
Manure from 6 yearlings @ \$9 each.....	54.00
TOTAL RECEIPTS.....	\$3003.85

Expenses

Feed purchased and fed:	
Wheat bran, 3 tons @ \$35.....	\$105.00
Linseed meal, 1½ tons @ \$62.....	93.00
Salt.....	4.50
Feed raised and fed:	
Corn, 230 bu. @ 70 cents.....	161.00
Oats, 300 bu. @ 40 cents.....	120.00
Red clover hay, 30 tons @ \$12.50.....	375.00
Pasture @ \$2.50 per cow per month and \$1.25 per month for yearlings.....	187.50
Corn silage, 80 tons @ \$5.25.....	420.00
Straw for bedding, 12 tons @ \$.75.....	9.00
Total value, feed and bedding.....	\$1475.00
Labor:	
Hired hand wages and board (one-fifth of time charged to dairy herd).....	\$200.00
Manager's labor, no wages and board, estimated value one- fourth time.....	400.00
Family labor.....	50.00
Horse labor, hauling feed and bedding, 340 hours @ 12½ cents.....	42.50
Depreciation on barn, fences, and milk house (value \$2800) @ 3%.....	84.00
Depreciation on dairy equipment and tools (value \$325) at 10%.....	32.50
Interest on buildings, herd and equipment (value \$5645) at 5%.....	282.25
Interest on land in lots @ 5%.....	6.00
Herd improvement association fee.....	42.00
Washing powder.....	3.00
Veterinary fees.....	18.50
Medicine and fly spray.....	6.50
Taxes and insurance, on buildings, herd and equipment.....	56.78
TOTAL EXPENSES.....	\$2699.03

in the business after taking account of all the expenses except interest, yet including labor and management, in this manner:

$$\frac{\text{Difference between receipts and expenses (less interest)}}{\text{total investment}} \times 100 \\ = \text{percentage returns on investment}$$

Taking the figures from the General Summary and substituting them in the formula,

$$\frac{\$3003.85 - (\$2699.03 - \$288.25)}{\$5645} \times 100 = 10.5$$

The returns on the investment in this case, therefore, were 10.5 per cent.

Many other calculations of value may be made by using the figures collected during the year. Some of these are suggested in the section which follows.

6. ANALYZING RESULTS OF YEAR'S BUSINESS

The returns calculated as directed in the foregoing section show whether the owner or manager has received an income for his year's work and whether there has been a return on the investment. These figures have a much greater value when compared with some standard, such as the records made in previous years, or the results from some other dairy herds.

Procedure:

- A. Compare results with those of previous years.
- B. Compare results with those of other farms.

A. Compare results with those of previous years. Keeping records year after year is necessary if the most profit is to be realized from the dairy herd. As soon as the returns for the year's business have been computed, compare the results with those of previous years. This may be done in much the same

way as in comparing the results of one dairy herd with another as outlined below.

B. Compare results with those of other farms. Records obtained in a school project in record keeping or in cooperative cost accounting work may be studied from the standpoint of:

- Productivity per cow;
- Quantity of grain mixture fed each cow yearly;
- Quantity of protein feed fed each cow yearly;
- Number of young stock raised.

These factors influence greatly the income from \$100 worth of feed fed.

Differences in productivity can be determined readily from the monthly and yearly summaries of milk and fat production. If it is found that a herd has a low production but has been well fed in comparison with others as determined from the amounts and kinds of feed used, then it is likely that more attention should be given to improving the quality of the herd, as outlined in Chapter VII.

The same method may be used for the study of other factors, such as:

- Cost per ton of protein feeds purchased;
- Cost per ton of grain mixture fed;
- Total herd cost of one hundred pounds of milk;
- Prices received for the product;
- Total cost of keeping the herd (average per head);
- Buildings and equipment cost for the herd (average per head);
- Expenses for each \$100 worth of income.

Two herds may have been equally well fed but the feed for one may have cost much less than for the other on account of the advantage of low market prices for feeds and the purchase of less expensive protein supplements.

Prices received for the product have an important bearing on profits. It may be found that one farm sold milk principally of grade B, whereas the more profitable farms produced grade A milk. Some farms may have sold sour cream while others

received a premium for sweet cream. A little more attention to cleanliness, involving only a small amount of additional labor and perhaps a small outlay for cooling equipment, as discussed in Chapter XI, might add greatly to the year's income and profits.

It may be found that the most profitable herds have a low feed cost and low total expense for each \$100 worth of income because legume hay is raised on the farm and fed very liberally, thus greatly lessening the expenditure for feed. Some



FIG. 126. THE COTTON CROP SUPPLIES A VALUABLE FEED FOR DAIRY COWS

The seed of the cotton is removed by the cotton gin and used for the manufacture of cottonseed meal and cottonseed oil. The cotton is then placed in bales like those shown here. The picture shows part of the 7000 bales temporarily stored in the yard and being moved into the warehouse in the background.

herds may be much smaller than the capacity of the barn used, thus entailing a high overhead expense in buildings.

Records of the most profitable herds should be given careful study, as they usually point the way to methods of increasing profits on other farms.

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 Petersen, W. E. *Dairy Science*. Chapters 35, 36. 1939. (Lippincott.)
 U.S.D.A. *Farmers' Bul.* 511, *Farm Bookkeeping*; 572, *A System of Farm Cost Accounting*; 782, *The Use of a Dairy for Farm Ac-*

counts; 1139, A Method of Analyzing the Farm Business; 1182, Farm Inventories; 1564, Farm Budgeting.

COMMUNITY STUDIES

Learn the names of several farmers in the community who are keeping business accounts with their herds. If no such farmers are known, consult the county farm adviser or write the agricultural experiment station of your state to find out if any farmers are keeping cost records under their direction. Make arrangements to visit such farms and ask the owner or manager to explain his methods of keeping accounts.

1. How is the annual inventory taken and of what does it consist?
2. How are the values of the different animals in the herd determined?
3. Upon what kind of a form are feed records kept?
4. Are feeds weighed and recorded daily, once weekly, or once monthly?
5. How are the values of the feeds (including pasture) determined?
6. How are records of income from the herd, such as sales of milk, cream, livestock, etc., kept?
7. Is the value of dairy products used in the home taken into account?
8. How is the value of the skim milk fed to pigs determined?
9. In summing up the business of the herd for the year, what items are included in the receipts and what items in the expenses?
10. What were the total returns and total expenses for the past year?
11. What were the net returns per cow, calculated on the basis of the average number of cows milked during the year?
12. What were the net returns from the herd in terms of percentage of the total investment in the herd?
13. What were the net returns to the owner after deducting all expenses except man labor?
14. What was the income for each \$100 worth of feed fed?

CHAPTER XVIII

PREPARING ANIMALS FOR SALES AND SHOWS

The principal factors in establishing the value of grade cows are nearness to calving, physical condition, and evidence of productive capacity. Therefore, a dairy farmer who owns a herd of grade animals usually does not consider that he would be repaid for the effort required to improve the appearance of his animals when he presents them for sale. In general, the price expected for grades will not justify any considerable expenditure in feed or energy to improve the appearance of the animals sufficiently to raise the sale price appreciably.

Purebred registered cattle, on the other hand, constitute an entirely different marketing problem. The markets for registered animals have less definite standards of value although the sale price, particularly for superior animals, is very much higher. The price that a registered animal will bring is, consequently, largely a question of personal opinion. The objective of the breeder of this type of cattle is to create a favorable impression and sway the opinion of the prospective buyer to a better perception of the merits of the animal. Purebred cattle breeders, well aware of this fact, spare no pains to prepare their best cattle in such a way that they will create a favorable impression on the mind of the prospective buyer.

Even more care is used in preparing an animal for shows and fairs than in getting it ready for sale. The general national increase in 4-H club work has added much to the impetus given to this type of exhibition. The procedures to be followed in selecting, training, posing, and preparing animals are essentially the same whether the animal is to be presented for sale or prepared for exhibition at a fair.

Operations:

1. Selecting the animals.
2. Training animals to lead and pose.
3. Condition the animals.
4. Preparing for show.
5. Shipping animals.
6. Making the final preparations.
7. Show a spirit of sportsmanship.

1. SELECTING THE ANIMALS

Great care should be exercised in choosing animals to be placed on exhibition. A responsible breeder who wishes to preserve his reputation will never offer for sale an animal that he is aware is defective or so low in quality or productive capacity that the prospective buyer is almost certain to be disappointed with his purchase. Animals of this type should be sold to the butcher.

Likewise, a thoughtful breeder will select only such animals for exhibition as are reasonably certain to create a favorable impression upon the observers at the show.

Procedure:

- A. Selecting animals for sale.
- B. Avoid personal preference in choosing show animals.
- C. Select animals that are well developed for age.
- D. Pay attention to topline and rumps.
- E. In milking animals choose good udders.
- F. Select for refinement with capacity.
- G. Reject animals with any serious defect.

A. Selecting animals for sale. An animal is usually sold from a purebred herd for one of two reasons. Either the animal is disposed of for beef when it is of doubtful value in the herd, or it is sold to another party for breeding and production purposes. In general, not enough purebred animals are disposed of for beef. The tendency is to retain all animals with even

the remotest possibility of having any breeding value. This is not good management practice, and more money has been lost by retaining such animals too long than has ever been lost by selling them too quickly.

In choosing an animal to be sold, especially in a public sale, select one that will be at its best when it is sold. The average buyer appreciates such an animal better and will pay more for it.

An animal to present the best appearance should be in good condition, carrying some surplus flesh, and be of the correct type. In club heifers, seller and buyer alike should have in mind the future favorable development of the animal.

B. Avoid personal preference in choosing show animals. Even though you may be familiar with all the animals in the herd, use extreme care in going over each individual that might be considered suitable for exhibition. Do not permit a personal liking for an animal to influence you in making your selections. Be guided only by actual facts.

It is highly important at this time that one select the animal which will, when in condition, present the best general appearance. This animal may not necessarily give the best impression at time of selection.

C. Select animals that are well developed for their age. Animals placed on exhibition are usually somewhat larger than the average for the breed. In selecting animals for exhibit, therefore, choose only those which are well grown and at least equal in size to the average expected for the age and breed. Extremely small animals, even though they may be especially smooth and fine in type, are undesirable for exhibit; on the other hand, unusually large animals are often coarse and unsymmetrical and should be rejected.

D. Pay special attention to topline and rumps. Breeders and judges demand straight backs and long, level rumps. Animals having uneven or badly sloping rumps, even though especially good in all other points, are rarely acceptable for exhibition purposes.

E. In milking animals, choose good udders. The udder of a dairy cow always should be given much consideration in selecting animals for breeding or exhibition purposes. Udders are most desirable when they are attached high and wide in the rear and are carried well forward and held snugly to the body in the front. The quarters of the udder should be equally developed. The teats, when most desirable, are evenly placed a good distance apart from side to side and from front to back.

F. Select for refinement with capacity. Choose an animal with a head that shows finely chiseled features and graceful lines, a neck that is long and slender, and withers and shoulders that show quality and refinement. The muzzle should be well developed and strong, indicating desirable feeding capacity, and the nostrils should be large and well distended. There should be ample spring of rib, especially of the upper rib, and the body preferably should be long and deep.

G. Reject animals with any serious defect. Even though an animal is otherwise acceptable, do not attempt to exhibit it if it has a serious defect, such as one-quarter of the udder not functioning (blind), a badly sloping rump, decided lameness, blindness, or any serious bodily defect.

2. TRAINING ANIMALS TO LEAD AND POSE

Excellent animals are frequently disappointments when on exhibition because they have not been taught to lead properly or to take and hold a desirable position for a reasonable length of time.

Procedure:

- A. Teach animal to lead readily.
- B. Train animal to back.
- C. Train animal to hold a good pose.

A. Teach animal to lead readily. Animals, both male and female, should be taught to lead when they are relatively

young. They learn more quickly then and are usually much easier to handle than when older. While walking, the animal should hold its head directly in front, with the poll several inches higher than the withers.

B. Train animal to back. The animal should be trained to back by having a slight pressure put on its shoulder. The

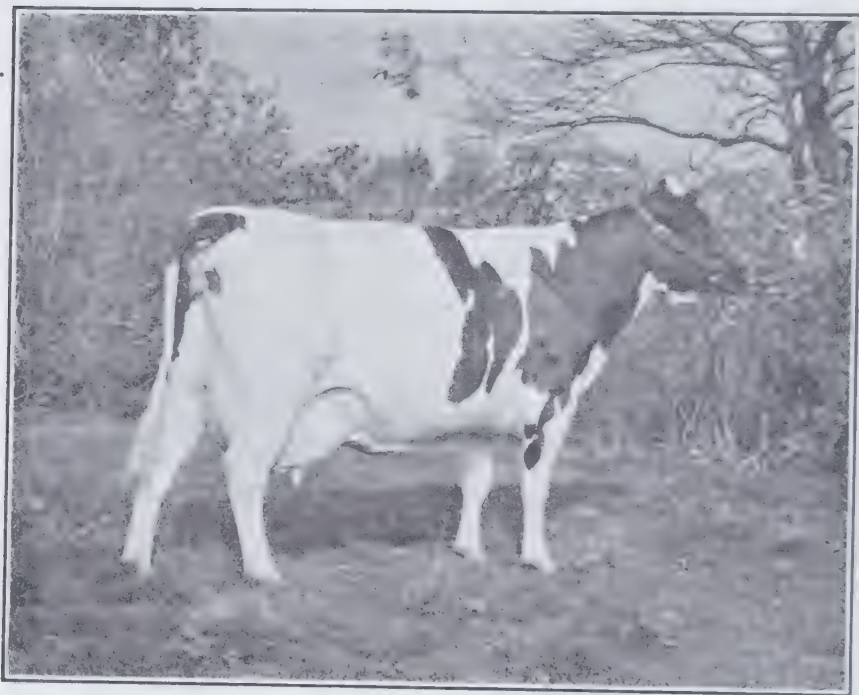


FIG. 127. COW SHOWING EXCELLENT POSE

Fine-type Holstein cow in remarkable pose, with head carried high, ears pointed forward, tail flowing backward, carriage alert, posture suggesting forward movement, and front and rear of udder both showing.

attendant can then make the animal take a desirable pose in close quarters, either by leading it forward a step or by backing it into position.

C. Train animal to hold a good pose. The good points of an animal will show off to much better advantage in the judging ring if it has been taught to stand well. Teach it to take a good position, standing squarely and naturally on its feet

with head well up and ears extended forward. Study the poses that show off its good points and train it to hold them as long as desired. Figure 127 illustrates such a pose.

3. CONDITION THE ANIMAL

To present the best appearance, an animal must carry a sufficient amount of flesh to cover the skeleton smoothly and show vigor and capacity. Too much fat tends to make even a good dairy animal look beefy.

The length of time required to get an animal into proper condition will depend upon the following factors: age, sex, period of lactation (in the cow), and original condition.

Young animals are usually more easily and quickly fitted than older ones. Heifers most often can be put into proper condition in sixty to ninety days. Cows should be in good flesh at calving time, and for this reason show best about this time. A cow with a good udder but lacking in body shows best just before calving, whereas one that is naturally deep in body but lacking in dairy tendency shows best after she has been in milk for a short time. Bulls, especially old bulls, generally require a longer time for fitting than do cows.

Procedure:

- A. Keep animals to be exhibited in a cool barn free from flies.
- B. Feed liberal amounts of a good grain mixture.
- C. Avoid excess fat and accompanying patchiness.

A. Keep animals to be exhibited in a cool barn free from flies. It is almost impossible to get an animal into proper condition, especially during the hot summer months, if it is running at pasture. Place all animals to be exhibited in as comfortable quarters as possible, and exclude flies by covering the doors and windows with burlap or other material.

B. Feed liberal amounts of a good grain mixture. Use the following ration for conditioning animals:

100 lb. ground oats
200 lb. hominy or ground corn
100 lb. bran
100 lb. linseed oilmeal
5 lb. salt

The amount of this mixture to feed depends upon the condition of the animal and the length of the feeding period. Very thin animals should be fed all they will clean up readily after having had free access to roughage. Well-fleshed animals require only enough grain to put them into proper condition. When feeding show animals mix the grain ration with water or molasses until it forms a slop. This method of feeding tends to develop a deep body which gives evidence of greater capacity. Furthermore, most animals, either young or old, will stand shipping better if they have been given slop feed.

C. Avoid excess fat and accompanying patchiness. Care must be taken not to get the animals in too heavy flesh, or they may become patchy; that is, fatty deposits may appear about the tailhead or other parts of the body. When the animals are in proper condition, and before there is evidence of any patchiness, lighten the ration by putting in more bran and oats. At the same time reduce the amount of corn or hominy and oil meal as well as the total amount fed. Usually, animals that are too well fitted at the beginning of a show season "go bad" before the later and more important shows, that is, they become too beefy in appearance, appear coarse and lacking in refinement, and create an unfavorable impression on judge or buyer.

4. PREPARING FOR SHOW

The skillful exhibitor pays careful attention to every detail in clipping, washing, blanketing, and preparing his animal for the ring.

Procedure:

- A. Clip animal carefully, if necessary.
- B. Wash animal thoroughly before each exhibition.
- C. Keep animal blanketed.
- D. Smooth and polish horns.

A. Clip animal carefully, if necessary. It is not advisable to clip an animal over the entire body unless the hair is extremely long and rough and the time for fitting is short. Do not clip animals that are thin in flesh, as clipping tends to make them look thinner. When clipping is necessary, it should be done six to eight weeks before the first show, or sale, except in the case of young, well-fleshed animals, when it may be done anytime before sale or show. When the condition of the hair over the body is satisfactory, clipping should be done only on the underline (except in the Ayrshire breed), on the neck and head, the tail, and occasionally along the higher processes of the back and over the withers. It is the custom of Ayrshire breeders to clip only the heads, necks and tails of their exhibition animals.

In clipping the tail, do not clip too low on the switch as this detracts from the appearance and symmetry of the animal. Irregularities on the back may be made less conspicuous by clipping the hair short on the high spots and leaving it unclipped over the depressions. If withers are to be clipped at all, they should be clipped from both sides in such a way that their sharpness will be accentuated.

B. Wash animal thoroughly before each exhibition. In summer, wash in cold water. When the weather is cool, it is advisable to use warm water. With breeds, like the Holstein and Ayrshire, which usually have a good deal of white on them and therefore soil badly, it is desirable to wash the entire animal; in other breeds it is necessary to wash soiled spots only. Use a good soap. Grandpa's Tar soap is excellent for two or three washings, but with repeated use it tends to darken the white portions. Washing with Lux will avoid this difficulty.

Rinse the animal well and remove the excess water with a scraper made of a smooth piece of wood, with or without a rubber edge. Complete the drying-out process by covering the animal with a lightweight blanket. Wool bed blankets are best for this purpose. In cool weather, use a lined stable blanket in addition. In warm weather the wool blanket should remain



FIG. 128. GUERNSEY BULL IN THE ROUGH

Observe the general lack of thrift, and the long, uneven coat of hair with bare spots over withers and rump.

on the animal approximately two hours or until the animal is dry; in cool weather it may be left on longer.

C. Keep animal blanketed. The continued use of a blanket on an animal to be exhibited prevents soiling and staining, and makes the hair lie down more smoothly. It protects the animal against drafts and sudden changes in temperature, and in summer against flies and insects. A lightweight duck or burlap

blanket is best for this purpose. In cool weather it may be desirable to use two blankets, such as the ordinary stable blanket with a flannel blanket underneath.

D. Smooth and polish horns. Dairy cattle show to the best advantage when they have shapely horns. In the case of certain breeds, notably Holstein, judges do not discriminate



FIG. 129. GUERNSEY BULL AFTER FITTING FOR SHOW

Photograph taken ten days later than Fig. 128. Note the thrifty, healthy appearance of the animal and the smooth, even coat of hair. With this bull clipping was done over the entire body.

against females that have been dehorned. Bulls of any breed appear best with horns. When horns are too long, from $3\frac{1}{4}$ to $11\frac{1}{2}$ inches of the tip may be removed. In long slender horns, the latter amount can usually be removed before the sensitive tissue is reached. In the broader type of horns, it may not be possible to remove so much.

Large horns and those badly marred should be scraped or rasped down until they are smooth and shapely. A small wood rasp is usually best for this purpose. Any marred places that still remain may be taken out with a horn scraper or a piece of glass. After the horns have been rasped, they should be smoothed with emery cloth, first with the coarse cloth and later with the fine.



FIG. 130. TRIMMING HOOFS

This equipment has proven very satisfactory for trimming hoofs in dairy cattle. The stall is made of pipe welded together and the floor consists of 3-inch oak boards that can be removed. The chisel, the wooden hammer, the file, and hoof knife comprise other equipment needed.

Upon the smooth surface of the horn, place a thin coating of tripoli powder and sweet oil mixed to the consistency of a thin paste. Polish with a strip of flannel cloth. Two or three such applications and rubbings should bring out a very high polish. When time is limited, horns that have previously been smoothed down and polished may be given a thick coating of olive oil. This gives a glossy polish, especially at night, but such a polish will not last for more than half an hour.

5. SHIPPING ANIMALS

It is usually preferable in making long shipments to ship by freight. Shorter hauls and local shipments are usually by truck. In either shipment it is important that animals arrive at their destination in good condition. The results of careful fitting can be lost in a single shipment if animals are not properly cared for when in transit.

Procedure:

- A. Make long group shipments by freight.
- B. Select ventilated car.
- C. Disinfect car or truck before loading.
- D. Carry feed and water in car.

A. Make long group shipments by freight. When animals are shipped by freight they must be accompanied by an attendant. With extremely valuable animals or young animals it may be advisable to ship by express. Express shipments of individual animals, especially club calves or young bulls for breeding purposes, are recommended where it is impractical to move such animals by truck. Whenever groups of animals are to be moved long distances, freight shipments are cheaper and more satisfactory. Express shipments, except for a cow in milk, do not require an attendant. Freight shipments, except for very short hauls, require a man in charge, who usually stays in the car with the animals.

B. Select ventilated car. If possible, select a car that can be ventilated. It is usually sufficient to fasten a side door open by putting several bars across the opening so that any animal that might get loose could not jump from the car. The size of the opening depends, of course, upon the temperature and weather. In extremely hot weather it may be necessary to have cross ventilation which is accomplished by opening both doors and putting bars across the openings as suggested above.

C. Disinfect car or truck before loading. Except in a new

car or truck that has not been used for livestock shipments thorough disinfection should precede loading. Any of the ordinary disinfectants, such as carbolic acid, cresol, lye, etc., are satisfactory for the purpose. Before such disinfectants are applied, the truck or car should be thoroughly cleaned out and scrubbed. After the surplus water has been removed, disinfecting materials may be used as a washing solution or sprayed on the sides and bottom of the car or truck. These same precautions apply to the transfer of animals from one herd to another. It is only in this way that all communicable diseases can be avoided.

D. Carry feed and water in car. Always provide your own pails and equipment. The practice of lending or borrowing pails is especially undesirable as it tends to spread diseases.

Cattle do much better if feed and water are provided for them when they are in transit. Make it a practice to carry more feed and water than will probably be required as accidents and delays frequently occur.

6. MAKING THE FINAL PREPARATIONS

The careful showman spares no pains to assure himself that his animals are comfortable and are being properly prepared for exhibition.

Procedure:

- A. Braid switches.
- B. Withhold water.
- C. Bed down heavily.
- D. Clean animals thoroughly and get equipment in readiness.
- E. Feed carefully.
- F. "Fill" to desired fulness.
- G. Give horns final polish, and rub down hair.
- H. Exhibit animal to best advantage in the ring.

A. Braid switches. The evening before the exhibition, wash the switches of the animals thoroughly with soap and

water and then dip them into a pail of water to which has been added a small handful of powdered alum. Alum water tends to make the tail fluffy when combed out for exhibition. Braid the switch into a number of small braids, and wrap these braids together and cover with a cloth to prevent soiling.

B. Withhold water. The evening before the show, do not allow animals that are to be exhibited to have access to water. The purpose in withholding water is to make reasonably sure that the animals will take on the desired "fill" at the time of exhibition. As an added stimulant to thirst, a double handful of salt should be given to each animal the night before the show.

C. Bed down heavily. While animals should be well bedded at all times, it is especially important to keep them clean the night before the show. Oftentimes an attendant is on duty during the night preceding the show, to remove the soiled bedding.

D. Clean animals thoroughly and get equipment in readiness. On the morning of the show, animals should be cleaned thoroughly. The udders of milking animals should be eased off preparatory to bagging. This will tend to prevent "hiving" or the skin from rising up in small welts over the body. At this time, also, get in readiness such equipment as halters, lead straps, bull staffs, etc. Pails should be filled with water, properly tempered, in readiness for use when animals are filled.

E. Feed carefully. On the morning of the show, do not give a large quantity of feed at one time, as this tends to make animals sluggish. Small amounts of grain fed at frequent intervals, together with the animals' desire for water, will tend to keep them alert.

F. "Fill" to desired fulness. About an hour before an animal is to go into the ring, it should be given water. If the weather is cold, take the chill from the water; otherwise the animal will hump up its back and shiver. Too much water is to be avoided as it tends to distort the appearance of the body

and makes the animal difficult to show. Take charge of this operation yourself. It should not be left to a stable boy who does not know when the animal is properly filled.

G. Give horns final polish, and rub down hair. Immediately after the animal is "filled" the horns should be given their final polish, the hair should be rubbed down, and the show halter put on. The animal is now ready for the ring.

H. Exhibit animal to best advantage in the ring. An animal should appear at its best at all times when in the ring. If it has been well trained, it can be made to take and hold the various positions which have been studied out as showing its good points to the best possible advantage. While in the ring, keep your eyes on both the judge and the animal. When a meritorious animal is not being noticed by the judge, the exhibitor can sometimes attract the attention of the judge by moving his animal into a more advantageous position.

7. SHOW A SPIRIT OF SPORTSMANSHIP

It is a disappointment to lead an animal into the show ring and have it fail to place, or place lower than is contemplated. This fact is made more difficult, especially for the beginner, because many of his or her friends will, without much thought of truth or fact, tell him that his animal is "outstanding and can't be beaten." Many heartaches have been caused by these thoughtless statements.

Judging is a matter of opinion. Opinions differ and the beginner should recognize this fact. Furthermore, competition, especially in 4-H and vocational-agriculture classes, is much keener and decisions must be made on smaller differences. An animal that placed first at one show may be "well down the line" in another, and the judges in both cases may be equally competent. This fact makes it appear desirable to have group placings so that animals of essentially equal merit may be given the same rating. By this plan there might be several animals in group one or the judge might conclude that none

of the animals merited so high a recognition, and place none in the first group but several in the second and still more in the third group, etc. Such a system is recommended to those responsible for the conduct of large 4-H judging contests.

Sportsmanship is a valuable asset to anyone. Learn to recognize and appreciate merit in another's animals. Do not be too deeply discouraged when your animals do not win. Try to determine why they did not have the same appeal to the judge as those in higher positions. Above all, congratulate the boy or girl who has a really good animal and has spent much time in training and preparing the animal for the show. Determine to put more effort into the next show or contest and you will be getting something of real value out of the show ring.

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CHAPTER XIX

BUYING AND SELLING DAIRY CATTLE

As long as cattle are produced, they will be bought and sold. The beginner must, of course, buy some cattle in order to establish his herd. The established breeder will find it desirable to acquire certain animals in order to incorporate through them the genetic qualities lacking in his own herd. Surplus animals will accumulate in older herds, and owners will find it necessary to sell some animals to keep their herds to the proper size.

Whether the dairyman buys or sells, and he will be obliged to do some of each in the management of his herd, he should understand at least some of the more important principles of marketing to protect not only himself but those with whom he deals as well.

Operations:

1. Buy only good, sound, healthy cattle.
2. Select cattle that will improve with age.
3. Sell cattle by effective methods.
4. Replenish the herd by growing young stock.

1. BUY ONLY GOOD, SOUND, HEALTHY CATTLE

The risk in buying cattle can never be entirely eliminated. Even the most experienced and careful breeders are occasionally disappointed in their purchases. Careful attention to the following procedure will repay the inexperienced breeder. The boy buying a club calf should carefully study this chapter.

Procedure:

- A. Determine definitely the kind of cattle you want to buy.
- B. Find the average selling price of such animals.
- C. Obtain information regarding reputation of breeders.
- D. If inexperienced, obtain opinions of experienced men.
- E. Be sure of the health of the herd from which you buy.
- F. Insist on tuberculin and abortion tests.
- G. Buy only superior animals.
- H. Quarantine animals before putting them into your herd.

A. Determine definitely the kind of cattle you want to buy.

Before you approach a dairyman from whom you expect to buy, decide on the type of animal that will best serve your purposes. Do you wish to buy heifers just coming into milk, or is the demand for milk such that you need mature cows which have reached their highest yield? Is it advisable to purchase cows for October calving and winter production, or would it be best to utilize pasture with cows that calve in May? All such questions should be answered before the purchase is made. Occasionally, one will find that cows of a particular kind or in a certain stage of lactation are in so great demand that the price has become prohibitive. In such cases it may be advisable to purchase cattle that are in less demand and therefore priced nearer their actual value.

B. Find the average selling price of such animals. After deciding on the type or kind of cattle that you desire to obtain, determine the average selling price for such animals. This can be done by consulting dairy papers for sale reports, by correspondence, or by getting the opinions of dairymen and farmers. While the market for both grade and purebred cattle is becoming somewhat standardized, there are rather wide differences in the value of individuals. It is usually desirable to obtain prices on animals in several herds before making purchases. In this way comparisons between animals can be made more readily and values determined more accurately.

C. Obtain information regarding reputation of breeders.

There is great opportunity for deception on the part of owners

in the selling of their cattle. It is therefore advisable to obtain information regarding the character and honesty of a breeder before effecting a purchase. Such information can usually be obtained from bankers, business men, breed associations, or nearby dairymen. It is never a good practice to deal with dishonest breeders or dealers.

D. If inexperienced, obtain opinions of experienced men.

One does not become skilled in the buying of cattle except by experience. The inexperienced person who lacks confidence in his own judgment should obtain the opinions of some experienced and successful dairymen and be guided by their judgment. Observe carefully the points which they regard as especially significant in the purchase of an animal.

E. Be sure of the health of the herd from which you buy.

Perhaps more dissatisfaction and disappointment have resulted from the purchase of animals from unhealthy or infected herds than from any other cause. Too much emphasis cannot be placed on this one fact. The status of the health of the herd may be determined in several ways. The two diseases that are most common and most generally feared in the purchase of cattle are tuberculosis and infectious abortion. The presence of the former disease can be detected with almost absolute certainty by means of the tuberculin test. Infectious or contagious abortion cannot be so readily detected and is in reality more to be feared.

Herds that are in normal health should produce almost as many calves per year as there are cows in the herd. About 50 per cent of the offspring will be bull calves, most of which will be disposed of at an early age. One would therefore expect to find about half as many heifer calves under one year of age as there are cows in the herd. Failure to do so should lead the purchaser to seek the cause. The facts regarding this condition can usually be obtained indirectly, by judicious questioning.

Whenever possible, it is advisable to have the blood of the animal that one intends to purchase tested for the presence of

abortion by the agglutination test. A positive reaction to this test should occasion the rejection of the animal.

F. Insist on tuberculin and abortion tests. Most states now require that all cattle brought across the borders of the state, except those intended for slaughter, be tested for the presence of tuberculosis. Cattle for breeding or dairy purposes should never be purchased without having been tested and pronounced free from tuberculosis. Animals should be purchased subject to a sixty- to ninety-day retest. In case of a reaction during that period the seller should stand the loss. Whenever possible a test for abortion should also be obtained.

It is important that these tests be accurately and honestly applied. For this reason it is desirable to have animals tested under the State and Federal Accredited Herd Plan.

G. Buy only superior animals. In general only superior animals should be purchased. It is better to purchase a few good animals than to use the same amount of money for a larger number of inferior ones. When one takes into consideration the high price of animals and the cost of shipping them, it is not good economy to purchase inferior individuals.

H. Quarantine animals before putting them into your herd. When one has a clean herd there is always some risk incurred by the introduction of an animal from another herd. It is therefore advisable to quarantine newly purchased animals until they can safely enter the herd. A quarantine of this nature usually covers sixty to ninety days, which makes possible a retest for tuberculosis and contagious abortion.

2. SELECT CATTLE THAT WILL IMPROVE WITH AGE

One of the authors once knew a man who owned horses for a period of forty-seven years. During that period he never lost money on more than one horse and never had one die on his farm, although he frequently owned as many as fifteen or more head at the same time. It is true that this man was for-

tunate in that no fatal contagious or infectious disease reached his farm, but his marked success was due to his ability as an outstanding judge of values and soundness in a horse and his good caretaking and feeding.

He knew those qualities that would improve with age and development and those that would grow worse at maturity. He never purchased an animal with the latter kind of weakness. He was an excellent judge of an animal "in the rough"; and long hair or lack of condition never caused him to underestimate an animal, nor did fat and finish cause him to overestimate one.

Procedure:

A. Study characters that improve with age.

B. Become familiar with defects that are certain to grow worse.

A. Study characters that improve with age. In Chapter III your attention was directed to two types of defects, those that improve with development and those that get worse. To purchase an animal with a defect or defects will bring disappointment. Breeders who sell animals should bear this fact in mind and not offer for sale breeding animals that will not give satisfaction. The purchaser who is able to recognize a good animal, thin in flesh but with good prospects, will usually find himself the ultimate owner of a good herd that is improving as it develops.

B. Become familiar with defects that are certain to grow worse. A good judge of cattle usually recognizes when an animal has reached its peak in value, and buys or sells on that knowledge. Study to become a good judge by observing many types of defects. Learn to differentiate between minor and major defects and apply the knowledge to purchases and sales.

3. SELL CATTLE BY EFFECTIVE METHODS

In this country there are two common ways of buying or selling cattle. These are by private treaty or through the

public auction. The former method is the more common though the latter is coming into extensive use. In either method, it is important for the seller to make known to the prospective purchaser just what he has for sale.

Procedure:

- A. Advertise in agricultural periodicals.
- B. Use circular letters and correspondence.
- C. Make use of good pictures.
- D. Make a special effort to satisfy customers.
- E. Sell through dispersal sales or well-managed consignment sales.

A. Advertise in agricultural periodicals. Because of their extensive circulation, agricultural papers are almost sure to reach prospective purchasers. Advertising in newspapers or in breed publications or trade journals must be skillfully done. In such cases, specific sale announcements or references to individual animals are most effective. Care must be taken that the cost of advertising is not out of proportion to the value of the animals advertised. In such advertisements, as elsewhere, it is necessary to state the truth regarding the animals listed.

B. Use circular letters and correspondence. Carefully prepared circular letters, when sent to a select mailing list, constitute valuable advertising. Such letters usually take the form of special sale lists and briefly describe each animal offered for sale.

Even when newspaper advertising or circular letters are responsible for inquiries, it is almost always necessary to close the deal by means of a letter or a personal interview. The ability to write attractive and convincing letters is an asset to any breeder, and especially to the owner of purebred cattle. Although letters should be brief and to the point, they should state all the facts that would be of interest to the purchaser. Furthermore, all correspondence should be answered promptly, preferably within twenty-four hours after it is received.

C. Make use of good pictures. Most breeders and dairymen do not make sufficient use of good pictures. There is no description, no matter how accurate, that is quite so convincing as a good clear picture of an animal. It is not necessary that such photographs be elaborate or costly. An ordinary kodak picture is sufficient if the animal is standing in a good position and if taken at a time when the animal shows to advantage.

D. Make a special effort to satisfy customers. A satisfied customer is one of the best advertisements a breeder can have. In selling animals be especially careful of the accuracy of all statements made. Understate rather than overstate the desirable characteristics of an animal. Mention defects that might be overlooked by a purchaser. The prospective buyer will appreciate your honesty in pointing out such defects and will be more willing to deal favorably with you. A sale made under misrepresentations cannot mean a satisfied customer and will react unfavorably on your business.

E. Sell through dispersal sales or well-managed consignment sales. Breeders who have only a few cattle to dispose of each year find it convenient to combine with their neighbors and market their cattle by means of a consignment sale. Such a method of marketing has the advantage of marketing the cattle at a definite time and usually to a favorable market. Dispersal sales are usually convenient ways of selling the entire herd when one is going out of the business. Such sales attract more and better buyers than consignment sales when cattle of equal quality are sold. Under such conditions the purchaser knows that he has an opportunity to buy the best animals in the herd. Such animals are seldom offered in a consignment sale.

It is seldom advisable for a beginner to buy at an auction sale. A great deal of enthusiasm prevails under such methods of selling and the inexperienced buyer is very likely to be unduly influenced by a clever auctioneer and pay more for an

animal than one of equal merit could be purchased for at private sale.

4. REPLENISH THE HERD BY GROWING YOUNG STOCK

It is the practice in certain milk-producing sections to replace members of a herd by purchase. Such a method is not generally conducive to improvement in the herd and takes away the opportunity to increase production by means of better methods of breeding. Many breeders who depend upon replenishing their herds in this manner have not been able to increase production over what it was ten or fifteen years before.

The purchaser of cattle is always at a disadvantage because he has had no opportunity to know the characteristics of an individual, but must depend entirely upon what he can see of the animal. There is also the danger of introducing disease by purchased animals, as well as the difficulty of getting a breeder to dispose of his better individuals.

Furthermore, there is constant depreciation in herds where older animals only are purchased, whereas there is a tendency for young animals to increase in value as they grow to maturity.

It has been found that three heifers must be grown each year from each ten cows kept, in order to insure the maintenance of the herd at its original size. It is only by keeping heifer calves from the best-type, highest-producing cows that the greatest improvement possible can be made in the development of a herd.

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CHAPTER XX

PLANNING AND EQUIPPING THE DAIRY BARN

A conveniently arranged dairy barn not only reduces to a minimum the labor of feeding and caring for the dairy herd, but also makes the work much pleasanter. Moreover, if the barn is to be used for the production of milk or cream for the retail trade, it is essential that provision be made to meet the requirements of local and state boards of health.

As a man seldom builds a dairy barn for his own use more than once during his lifetime, it is wise, in making plans, to take advantage of those principles which have been generally adopted by good dairymen. The chief of these principles are discussed below. For detailed plans showing standard types of construction, consult your state agricultural experiment station, the Bureau of Dairying of the United States Department of Agriculture, or barn-equipment companies that have barn-plan service departments. For specifications covering sanitary requirements in barns and milk houses, consult your local or state board of health.

Operations:

1. Planning the barn.
2. Equipping the barn.

1. PLANNING THE BARN

Much thought should be given to the location and plan of the dairy barn. Both the convenience of the attendants and the comfort and well-being of the animals should be taken into consideration.

Procedure:

- A. Select best site available.
- B. Choose type of barn to meet your conditions.
- C. Calculate size of barn required.
- D. Decide upon arrangement and construction of stalls.
- E. Plan for housing of young stock.
- F. Plan for maternity pens.
- G. Provide sufficient light.
- H. Arrange for a good ventilation system.
- I. Include a suitable milk room.
- J. Arrange convenient exercising yards.

A. Select best site available. Study the arrangement of the other farm buildings, the slope of the ground, the direction of the winter winds, and the possible location of exercising yards, in order to select the best possible site for the dairy barn. As convenience in getting work done is one of the most important factors, location of barn with reference to other buildings is generally of first importance. Good natural drainage for barn and lots is very desirable. When this can not be secured, employ artificial drainage and grading, if possible, so that water will drain away quickly from the barn and yards. Locate the barn so that it will form a windbreak for at least one side of the exercising yards.

Consider also the possible future location of a silo and milk house so that they will be convenient to the barn and so that the milk house will also be convenient to the water supply.

B. Choose type of barn to meet your conditions. Before drawing plans for your barn, study the many different types of dairy barns in use. Read the discussion and note the illustrations of different types of barns as given herewith. Visit some barns on the best dairy farms in your community; or, if there are no good examples of modern construction among the neighboring farms, consult your farm adviser or write your agricultural experiment station to help you locate some. Write some of the barn-equipment companies for their books of general plans. From the observations and information thus

gained, choose the type that seems best suited to your conditions.

Different types of dairy barns are found prevailing in different communities or sections of the country, as the result of the nature of the land, the need for storage space, or community preferences. The following are some of the more common types:

The *two-story*, or *loft*, *barn* is suitable for a level country



FIG. 131. GOOD QUARTERS MAKE FOR HEALTHY CATTLE

Barns which are clean and well ventilated are conducive to the rearing of healthy cattle. Note the great number of windows and the ventilator near each window. Silos and separate feed-storage barn are shown nearby. This figure illustrates an excellent one-story barn.

where driveways to the mow floor are not common. A barn of this type can be readily lighted and ventilated, provides hay storage convenient to the cattle, and is generally one of the best suited for housing dairy cattle.

The *basement*, or *bank*, barn is common where the ground is rolling or hilly. One side of the barn is built next a bank and a driveway leads to the second floor. Such barns are generally very poorly lighted on the side next the bank, and, on account of masonry construction of the basement, tend to be

damp. Barns of this type are satisfactory when provided with sufficient light and good ventilation.

The *round barn* of moderate size (not exceeding 60 or 70 feet in diameter) is a type that is also readily lighted and ventilated. The first floor can be very conveniently arranged for the care of cows in stanchions. The round barn has several limitations, such as the difficulty of using a hay carrier, weakness of construction, etc., and therefore is preferred by but few dairymen.

The *one-story* barn is preferred by some dairymen who are



FIG. 132. MODERN DAIRY BARNs MUST BE SANITARY

State laws and city ordinances covering most areas in which milk is produced for the retail trade require that dairy barns be well lighted and well ventilated, have impervious floors, and possess other construction features that help to keep them in a sanitary condition. The barn illustrated is a good example of one that meets these requirements.

making a specialty of high-grade milk. Barns of this type have no feed storage above the cows, the feed being kept in another building which may be either separate or closely connected with the cow barn. This type of barn is suitable for warm climates where strong construction and ceilings are not needed. Windows or ventilators may be placed near the ridge so that they quickly carry off the warm air.

The *covered barnyard* connected to a milking barn is occasionally used. The milking barn may be large enough for all or for only a part of the cows in the herd. The cows are

kept in the barn only while being milked and fed silage and grain. Dry roughage is fed in racks in the covered yard. Fifty to 65 square feet of floor space per cow is required in the yard. Large amounts of bedding must be provided in the yard in order to keep the cows clean. This plan of housing dairy cattle is used on relatively few farms.

C. Calculate size of barn required. The usual arrangement of cows in dairy barns is two rows of cows lengthwise of the barn. This requires, in a barn of frame construction, an outside width of 34 to 36 feet. If heavy masonry walls are used, 2 feet more should be allowed.

The length of the barn is easily calculated from the number of cow stalls, each stall usually being about 3 feet 6 inches in width. Allow 4 feet in addition for walks at each end of the barn; and if more than twenty stalls are in a continuous row, allow 3 feet for a cross alley through the middle of the barn. It is best to draw the floor plan first, arranging the stalls, pens, walks, etc., as desired, and from this plan determine the size of the barn necessary. Do not choose definite outside dimensions first and then expect to be able to make the interior arrangements ample and convenient.

D. Decide upon arrangement and construction of stalls. Consult dairymen who have herds about the size of yours, in regard to the best arrangement of the stalls. Experience has shown that for the best lighting and the greatest convenience in caring for the cows, dairy barns should be wide enough to accommodate two rows of stalls arranged lengthwise of the barn.

Two arrangements of the stalls are common. In one plan the two rows of cows face each other, or "face in," as it is termed; in the other plan the rows of cows face the side walls, or "face out." Both plans have many advantages and some disadvantages.

The stall should be planned to give the cow a comfortable place to stand and lie down, and should be of such length that the droppings will fall in the gutter and not on the stall platform.

Since the breeds of cattle differ in size, both the length and the width of the stall should be planned for the breed to be housed. Jerseys and Guernseys require a platform 4 feet 4 inches to 4 feet 10 inches in length and 3 feet to 3 feet 8 inches in width. Holsteins, Brown Swiss, and Ayrshires require a

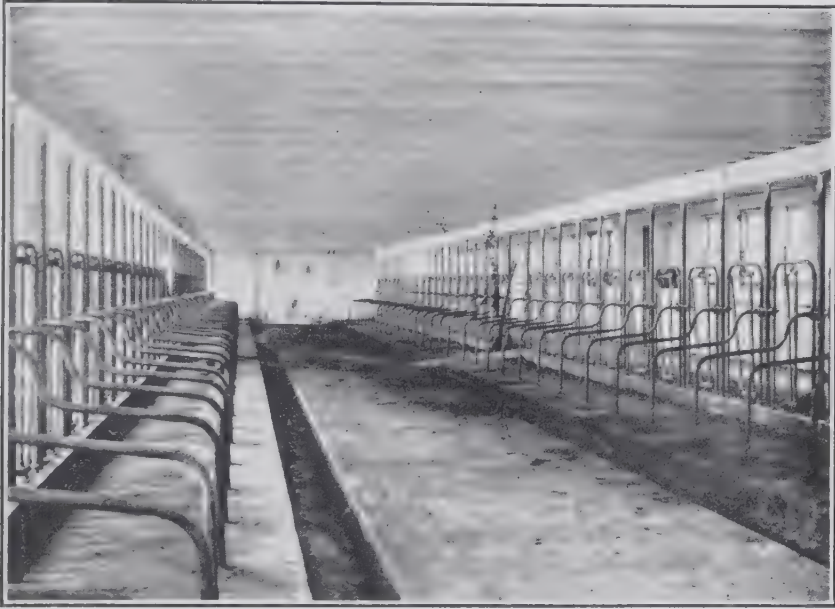


FIG. 133. LARGE DAIRY BARN IN WHICH COWS FACE OUT, THAT IS, TOWARD THE WALLS

The manure is removed by loading into a manure spreader driven through the barn.

platform 4 feet 8 inches to 5 feet 4 inches in length and 3 feet 6 inches to 4 feet in width.

The cows in a herd usually differ in size, the two-year-olds being much smaller than the mature cows. For this reason, stalls of different sizes should be provided. This can be done by varying the length of the platform throughout the barn and by having the stalls narrower where the platform is shortest.

The floor of the stall should slope $\frac{1}{2}$ inch to 1 inch toward the gutter.

When little or no bedding is used in the stalls, concrete floors are cold and damp, particularly in northern climates. Various means are used to remedy this objection, since concrete construction is especially desirable in the cow barn because of its durability and sanitary features.

A sub-floor of concrete, 3 to 4 inches thick, may first be laid in the stall, and then overlaid with a floor of corkbrick or creosoted wood blocks, manufactured especially for this purpose. The joints are filled in with an asphalt preparation. A retaining wall or curb of concrete, next the gutter, must also be constructed to hold the bricks or blocks in place.

Another effective device employed for the same purpose is to imbed in the concrete floor, next the manger curb, a 2- by 4-inch or 2- by 6-inch strip. Planks are then laid lengthwise of the stall so that they completely cover the floor from manger to gutter and are nailed to the imbedded strip.

It is very important that the gutter be deep enough, so that the cows will not lie on the droppings. The floor of the gutter is usually 8 to 10 inches below the stall floor and 4 to 6 inches below the floor of the driveway or litter alley. The width of the gutter should be 16 to 18 inches. Gutters of different types are used satisfactorily. Unless sufficient bedding is used to absorb all the liquid manure, drains should be placed in the gutter and the floor of the gutter should slope 1 inch in 25 feet toward the drain.

E. Plan for housing of young stock. Since the growing stock determines the future of the herd, provision must be made for their shelter also. Young calves are subject to pneumonia and other diseases when housed in cold, drafty quarters. Pay special attention to securing comfortable calf pens and stanchions for yearlings.

In cold climates, young stock are housed best in the same stable as the cows, in order that the small calves, in particular,

may be kept warm. Such an arrangement, however, may not be practicable in herds in which high-grade milk is being produced. If separate quarters are necessary, they should be conveniently situated with respect to the milking herd in order to save labor in feeding and care.

Separate barns for young stock do not require so high a ceiling as do cow barns. In fact, the entire arrangement should be compact, so that the heat from the animals may warm the barn as much as possible.

The pens are convenient when arranged on both sides of a central feeding alley, extending from the alley to the side walls of the barn. See Fig. 101. Gates may be placed in each of the pen divisions next the wall, to permit cleaning. This is a more economical use of space than to have alleys next the walls and through the center also.

F. Plan for maternity pens. Arrange one box stall to be used as a maternity pen for every 12 to 15 cows in the herd. These pens may often be used for young stock also, but they should be available for the cows at calving time.

G. Provide sufficient light. Few barns have too much light. Plenty of light helps to keep the barn sanitary and makes the surroundings pleasant for both the animals and their attendants. Four square feet of glass per cow or 1 square foot for each 20 square feet of floor space are standard guides for calculating the size of windows. In northern climates, double-glazed windows or storm sash are occasionally used to help keep the barn warm.

Locate the windows so that the light is uniformly distributed through the stable. Place them at least 4 feet above the floor in order to prevent breakage. They may be hinged at the bottom so that they open inward at the top to help provide ventilation.

H. Arrange for a good ventilation system. Pay particular attention to the ventilation of the barn, especially if you live in a cold climate, for the health of the herd is very dependent upon

it. Secure authoritative information on this subject from some of the sources mentioned.

I. Include a suitable milk room. Do not overlook the location of a room suitable for weighing, straining, and cooling the milk. This room should be separated from the main part of the barn by a short passage having a swinging door at each end. If the milk is not to be cooled in the room where it is to be weighed and strained, plan a separate milk house with a cooling tank.

J. Arrange convenient exercising yards. Plan for yards into which the cows can be turned on pleasant days in winter. Arrange these to the south of the barn or in a sheltered location. Construct a separate yard for the small calves, preferably located in a sheltered, sunshiny place.

2. EQUIPPING THE BARN

Steel tubing is now commonly used for the construction of stalls and pens in dairy barns. Equipment of this kind has the advantage over wooden equipment of being easily cleaned and disinfected.

Procedure:

- A. Install durable, sanitary equipment.
- B. Select swinging stanchions.
- C. Provide individual water bowls.
- D. Install litter carriers on tracks.
- E. Purchase or make feed trucks.

A. Install durable, sanitary equipment. Before completing plans for the barn, consult some barn-equipment company or its sales agency, regarding equipment. Where concrete floors and mangers are to be used, the steel-tubing equipment must be set in the concrete as it is being poured. This equipment may also be used with wooden floors. Whichever construction is used, however, it is necessary to have complete plans and direc-

tions for installing the equipment before drawing final plans, so that provision may be made for curbs, stalls, etc., of the proper size.

B. Select swinging stanchions. The swinging stanchion is preferable to the old-style rigid stanchion as it permits the animal much more freedom of movement. The stanchion may be all steel, steel with wood lining, or all wood. The steel stanchion is preferable on account of its neatness and strength.

C. Provide individual water bowls. Equip the stalls with individual water bowls so that the cows may drink whenever



FIG. 134. INTERIOR OF A WELL-EQUIPPED DAIRY BARN

The two rows of cows face in, or toward each other. Litter carriers are used to remove the manure. A feed carrier is employed to bring feed to the cows. The stalls are provided with name plates, and automatic water bowls, and are floored with an insulating material. Note the ventilator inlet flues in the ceiling above the feed alley, and at the right the large window sash which tilts inward at the top. A special feature of this barn is the raised feed alley, making manger fronts unnecessary.

they wish. Some water bowls are double and some single, but usually two cows may drink from a single bowl if it is placed between them. Slope the pipes so that they can be thoroughly drained on cold nights to prevent freezing.

D. Install litter carriers on tracks. When the stalls are arranged so that there is a central feeding alley, install litter carriers on tracks for convenience in carrying the manure from the barn to a manure spreader or pit outside. The lines of track should be placed so that the carriers will hang over the litter alley and close to the edge of the gutter. If several litter carrier loads are to be handled daily, the largest-sized carriers save time.

In barns in which the cows face out, litter carriers may also be used, instead of a manure spreader or wagon, to remove



FIG. 135. A GOOD EXAMPLE OF A BASEMENT DAIRY BARN

The barn has a heavy masonry wall but is provided with a goodly number of windows and a modern ventilation system. Note the large storage capacity for hay and silage. Only a well-established and well-managed dairy farm can afford an investment as heavy as that represented here.

the manure. If this arrangement is used, two lines of carrier track are necessary.

E. Purchase or make feed trucks. If the floors or walks between the feed storage and the cow stable are smooth, use feed trucks for taking silage, concentrates, and in some cases hay, to the cows. In small herds, silage and concentrates may be carried in a basket.

Trucks designed especially for this purpose may be purchased. To construct a feed truck at home, proceed as follows: Make a strong box, 30 inches wide, 30 inches deep, and 5 to 6

feet long. Secure a pair of iron wheels, 10 to 18 inches in diameter, mounted on an iron pipe as an axle. Place the axle under the box about one-third the distance from one end. Under the other end, on a swivel mounting, place an iron wheel about half the diameter of the other wheels.

GENERAL INFORMATION

Whitewash—government formula. Slake $\frac{1}{2}$ bushel of quicklime with boiling water, covering to keep in steam. Strain through a fine sieve. Add a peck of salt previously dissolved in warm water, 3 pounds of ground rice boiled to a thin paste and stirred in while hot, and $\frac{1}{2}$ pound of Spanish whiting. Add 1 pound of glue dissolved by mixing with cold water, placing the kettle containing the mixture in a larger one filled with water, and then heating over a slow fire. Add 5 gallons of hot water, stir, cover and let stand a few days. This whitewash should be applied hot by means of a brush. One pint covers about one square yard and makes a durable coating. Coloring matter may be added if desired.

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CHAPTER XXI

CARING FOR MANURE AND CONSERVING THE SOIL

The American people at last have become conscious of the need of soil conservation. This realization is largely a recognition of and, to a certain extent, the acceptance of the United States Department of Agriculture's general conservation program. The dairy industry, largely through its extensive use of pasture and hay crops, is a supporter of and benefit by soil conservation.

Enormous losses of fertility occur on dairy farms each year, largely through a lack of proper care of manure. Dairy farming offers one of the best means for conserving soil fertility and even for building up run-down soils, but this can not be accomplished unless manure produced on the farm is well cared for. It has been conservatively estimated that fully one-third of all manure produced in this country is lost through poor care, a loss amounting to millions of dollars annually.

The cow excretes two-thirds to three-fourths of the fertilizing elements originally contained in her feed, in manure. Approximately half this amount is in the solid excrement, or dung, and half in the liquid excrement, or urine. For this reason, both the liquid and the solid manure should be conserved.

Operations:

1. Determining the fertilizing value of manure.
2. Collecting the manure.

3. Storing the manure.
4. Using green manures and commercial fertilizers when necessary on dairy farms.

1. DETERMINING THE FERTILIZING VALUE OF MANURE

The tendency of the average farmer is to underestimate both the amount and value of the manure produced on his farm. Table XXXVIII shows the daily and annual yield of manure for each 1000 pounds live weight of the various classes of animals usually kept on a dairy farm.

TABLE XXXVIII
MANURE PRODUCED PER 1000 POUNDS LIVE WEIGHT
BY DIFFERENT CLASSES OF FARM ANIMALS

Class of Animal	Daily Production, Pounds	Annual Production, Tons
Horses	48	9.0
Cows	85	15.0
Hogs	98	18.0
Poultry	23	4.25

Procedure:

- A. Study the chemical elements required in plant growth.
 - B. Note the plant-food elements in farm crops.
 - C. Determine the plant-food elements in manure.
- A. Study the chemical elements required in plant growth.**
There are ten principal and several other essential elements of plant food known to be necessary to the growth of plants. Three of these are supplied by air and water, and the remainder are derived from the soil.

Supplied by Air and Water	Derived from the Soil
1. Carbon 2. Hydrogen 3. Oxygen	1. Nitrogen 2. Phosphorus 3. Potassium 4. Calcium 5. Sulphur 6. Magnesium 7. Iron

Of the elements derived from soil the first four named are most frequently responsible for limiting or reducing crop yields.

B. Note the plant-food elements in farm crops. When a given weight of a certain crop is taken from the soil, there is removed from that soil in that crop certain elements of plant food. Unless provision is made for the return of those elements, the soil becomes gradually depleted. Table XXXIX shows the weight of each of the seven elements of plant food supplied by the soil and found in different amounts in our common crops.

TABLE XXXIX
PLANT-FOOD ELEMENTS IN COMMON FARM CROPS

Produce		Nitro- gen, Pounds	Phos- phorus, Pounds	Sul- phur, Pounds	Potas- sium, Pounds	Mag- nesium, Pounds	Cal- cium, Pounds	Iron, Pounds
Kind	Amount							
Wheat, grain . . .	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat, straw . . .	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs	1 ton	4.00	.....	....	4.00	.....	.....	....
Oats, grain	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed	1 bu.	1.75	.50	....	.75	.25	.13	....
Clover hay	1 ton	40.00	5.003	3.28	30.00	7.75	29.25	1.00
Soybean seed . . .	1 bu.	3.22	.39	.27	1.26	.15	.14	....
Soybean hay . . .	1 ton	43.40	4.74	5.18	35.48	13.84	27.56	....
Alfalfa hay	1 ton	52.08	4.76	5.96	16.64	8.00	22.26	....

These data have been brought together from various sources. Some allowance must be made for the exactness of the figures because samples representing the same kind of crop or the same kind of material frequently show considerable variation.

Using the values supplied by the above table, we find that a 75-bushel crop of corn, in grain only, removes from the soil 75 pounds of nitrogen, 12.75 pounds of phosphorus, 6 pounds of sulphur, 14.25 pounds of potassium, 5.25 pounds of magnesium, and .75 pound each of calcium and iron. When the stalks are also removed, a very much greater loss is incurred.

C. Determine the plant-food elements in manure. In order that students may have a better understanding of this question, Tables XL and XLI are presented. The former gives the average daily production of manure, both solid and liquid, by the four common classes of farm animals found on dairy farms, and the latter gives the percentage composition of the manure.

By using these figures it is possible to compute the value of the yearly production of each animal listed. It must be kept in mind, however, that, unless the manure is properly cared for, many of these elements are lost rapidly.

2. COLLECTING MANURE

When cows are at pasture, the manure falls in the field and is, of course, returned directly to the soil. When the cows are in the barn the following suggestions should be put into operation:

Procedure:

- A. Use enough bedding to absorb liquid manure.
- B. Remove manure from the stable at least once each day.
- C. Spread manure on pastures by drag or harrow.
- D. Clean lots and around feed racks frequently.

A. Use enough bedding to absorb liquid manure. The best way of saving the liquid manure and applying it to the soil is

by the use of a large amount of dry bedding. Straw and shredded corn stover are among the best materials for bedding, for they not only absorb the liquid manure readily, but also

TABLE XL

DAILY YIELD OF SOLID AND LIQUID EXCREMENT FROM MATURE ANIMALS

Class of Animal	Daily Production per Animal		Dry Matter	
	Solid, Pounds	Liquid, Pounds	Solid, Per Cent	Liquid, Per Cent
Horses.....	35.5	8.0	24.3	9.9
Cattle.....	52.0	20.0	16.2	6.2
Hogs.....	6.0	3.5	18.0	3.3
Hens.....	.1	.....	35.0	.....

TABLE XLI

COMPOSITION OF FRESH EXCREMENT

Class of Animals	Nitrogen		Phosphoric Acid, P ₂ O ₅		Potash, K ₂ O	
	Solid, Per Cent	Liquid, Per Cent	Solid, Per Cent	Liquid, Per Cent	Solid, Per Cent	Liquid, Per Cent
Horses....	.50	1.20	.30	Trace	.24	1.50
Cattle....	.32	.95	.21	.03	.16	.95
Hogs.....	.60	.30	.46	.12	.44	1.00
Hens.....	1.00	.....	.80	.....	.40	.....

contain, in themselves, a large amount of the elements that make for fertility. Shavings, sawdust, refuse, hay, etc, may also be used. Bedding materials that are very dusty should

not be used in barns where high-grade milk is being produced.

As a help in supplementing manure, raw rock phosphate, or acid phosphate is sometimes spread in small amounts in the gutters. In such cases, use about 100 pounds of rock phos-



FIG. 136. REMOVING MANURE FROM THE BARN BY MEANS OF A LITTER CARRIER

The use of modern equipment greatly reduces the labor in the barn where there are many animals to be cared for.

plate or 50 pounds of acid phosphate for each ton of manure produced.

The addition of this material not only increases the fertility value of the manure, which is usually somewhat deficient in

phosphorus, but also when applied in this way insures its becoming mixed with the manure and tends, at the same time, to aid in the retention of nitrogen. Before using phosphate extensively, it is well to test the soil for available phosphorus by using the colorimetric test.¹ In the event that certain fields or portions of the farm show a deficiency of available phosphorus,



FIG. 137. AN EFFECTIVE MEANS OF KEEPING THE BARN LOT CLEAN

The equipment shown here makes the loading of manure directly from the stable into the manure spreader so simple that the barnyard can be kept clean during those seasons of the year when it is possible to haul the spreader from the yard.

it is advisable to use the phosphated manure on those areas, fertilizing the remainder of the farm with untreated manure.

Liquid manure may also be saved by collecting it in a cistern connected with the gutters in the stable by drains of sewer pipe (tile cemented at the joints). For sanitary reasons, the cistern should be 100 feet or more from the barn and should be kept tightly covered. It may be emptied by

¹ Bul. 337, Ill. Agr. Exp. Sta.

means of a pump and tank wagon, and the liquid hauled to the fields and applied directly to growing crops.

B. Remove manure from the stable at least once each day. Make it a practice to remove the manure from the stable at least once, but preferably twice, each day. This may be done by loading it into a litter carrier or by means of a wagon or manure spreader driven through the barn. At the same time, distribute the bedding evenly in the stalls, placing some in the gutters and adding fresh bedding if necessary.

C. Spread manure on pastures by drag or harrow. It is good pasture management to spread frequently the droppings of cows at pasture. This accomplishes two purposes: first, it spreads the solid manure uniformly over the soil and protects the grass; second, it reduces the opportunity for horn flies to breed in the moist droppings.

D. Clean lots and around feed racks frequently. It adds much to the appearance of a barn lot to keep it free of waste hay and manure. This procedure destroys one of the breeding places of horn flies, one of the pests of dairy cattle. The accumulation around feed racks also serves as a breeding place for house flies, a menace to sanitation in the barn and milk house.

3. STORING THE MANURE

The simplest method of handling manure, from the standpoint of labor, is to haul it in a manure spreader to the fields each day; but for several reasons this is not always practicable. The land may be such that if manure were applied during the winter much of it would wash away. The snow may be too deep, or the ground too soft, to permit the use of the manure spreader. In such cases, good storage should be provided, for rain rapidly leaches away much of the value of the manure if it is left in an exposed pile.

Procedure:

- A. Store manure in well-constructed, compact piles.
- B. Store the manure under cover to prevent leaching.
- C. Keep the manure compact and moist.

A. Store manure in well-constructed, compact piles. There is always a certain amount of loss in fertilizing elements when manure is stored. The method of storing is, however, an im-

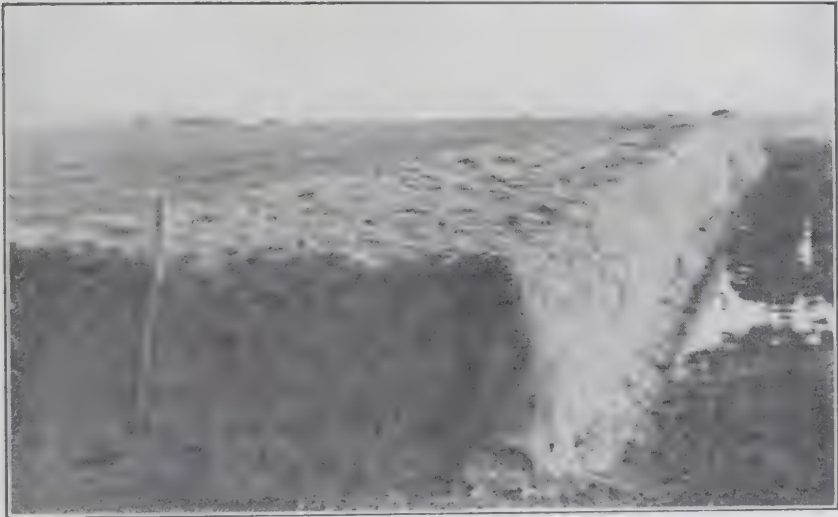


FIG. 138. COMPOST PILE PROPERLY CONSTRUCTED

A compost pile should, when finished, give the appearance indicated in this photograph. Manure preserved in this way retains a considerably higher portion of its fertilizing constituents than when placed in low piles over a greater area.

portant factor in reducing this loss to a minimum. Manure stored outside should be placed in broad piles with sides straight up and down, very much as hay is placed in a rick. It is usually desirable to make the pile at least 10 feet wide and 6 to 8 feet high. Always add fresh manure to one end of the pile and not at different points along its length.

A tarpaulin placed over the freshly added manure will not only prevent flies from breeding in the manure, but will also kill many of the maggots already in the manure, as they can-

not endure the heat generated under the tarpaulin. Table XLII shows the loss of nitrogen in manure when exposed to rapid drying.

TABLE XLII
LOSS OF NITROGEN FROM COW MANURE BY DRYING

Time and Temperature	Portion of Original Nitrogen Lost			
	Ammonia Nitrogen		Total Nitrogen	
	Still Air, Per Cent	Moving Air, Per Cent	Still Air, Per Cent	Moving Air, Per Cent
12 hours at 68° F.....	15.2	49.4	7.7	25.1
36 " " " " ".....	46.0	61.0	23.4	30.9
3½ days " " " " ".....	63.9	70.0	32.4	35.6
7 " " " " ".....	71.3	73.5	36.2	37.3

Exposure for three days removes more than half of the ammonia nitrogen and thirty-five per cent of the total nitrogen from fermented cow manure. Other fertilizing constituents are not so rapidly removed.

B. Store the manure under cover to prevent leaching. A common method of storing manure in some sections is to push it through trapdoors in the gutters into a basement below. This is a simple method of handling and storing, but it has disadvantages from the sanitary standpoint.

A better method of caring for manure, as it is removed from the barn, is to store it in a covered shed or pit 50 feet or more from the barn. It can then be removed to the fields when desired.

C. Keep the manure compact and moist. In storing manure, place it in a deep pile to make it compact and to help retain its moisture. If necessary in hot weather, add enough water to prevent fermentation, as losses of nitrogen occur if fer-

mentation takes place. Such losses may be partly prevented by sprinkling over the manure a small amount of acid phosphate or, in some cases, gypsum. The former is superior be-



FIG. 139. COVERED MANURE PIT FOR PRESERVING MANURE UNTIL IT CAN BE TAKEN TO THE FIELDS

Leaching away of the valuable elements of fertility by rain is prevented in a manure pit of this type. The manure may be loaded from the pit directly into a manure spreader driven along the open sides.

cause it also supplies phosphorus. Both tend to keep down odors from manure which is in storage.

4. USING GREEN MANURES AND COMMERCIAL FERTILIZERS ON DAIRY FARMS WHEN NECESSARY

Legumes, when properly inoculated, incorporate atmospheric nitrogen in their foliage and roots. Plowing under such legumes adds nitrogen in a cheap and readily available form to the soil and increases the yield of subsequent grain crops.

Procedure:

- A. Green manures aid in the decomposition of stable manure.
- B. Study availability of plant food before applying commercial fertilizers.

A. Green manures aid in the decomposition of stable manure.

Plowing under green crops, grasses, or even weeds aids materially in increasing the rate of decomposition of barn manure that may have been applied to the field. Similarly, green manure appears to aid in making available plant food somewhat deficient or tightly locked in certain types of soil.

B. Study availability of plant food before applying commercial fertilizers. Some sections of the country and certain types of soil yield better and more economically when commercial fertilizers, supplying the deficient plant foods, are added. It is always desirable, however, to test the soil for available phosphorus or to determine the acidity before money is invested in commercial fertilizers.

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CHAPTER XXII

PROVIDING A SOUND BASIS FOR THE FUTURE

Reasons for believing that dairy farming will continue as a fundamentally sound industry are discussed in Chapter I. Assuming that dairy farming will continue, what factors must be given careful attention in order that good returns may be obtained?

Because consumption and prices of dairy products are closely related to industrial pay rolls and are also affected by competition with other foods, world markets, international relations, and other factors, it is impossible to make any sound predictions with regard to probable price conditions in the future. Experiences of the past few years indicate a trend toward lower margins of profit in the production of milk and butterfat (Table XI). In order to meet such trends and to insure fair returns, even under changing economic conditions, special attention must be given to attaining the greatest possible efficiency in the factors of production. Some of these factors are reviewed briefly herewith.

Management factors:

1. Obtain high production per cow.
2. Produce a high-quality product.
3. Provide a diversity of enterprises.
4. Consume dairy products at home.
5. Help to advertise dairy products.
6. Conserve soil fertility.

1. OBTAIN HIGH PRODUCTION PER COW

The remarkable differences in the production and returns from cows in dairy herds and the necessity for selecting each cow individually were first called to the attention of the public forty years ago through the work of Professor W. J. Fraser of the University of Illinois. Professor Fraser esti-



FIG. 140. HIGH-PRODUCING COWS ARE THE BEST ASSURANCE OF A SUCCESSFUL DAIRY ENTERPRISE

The dairy farmer who possesses a herd of healthy, high-producing cows is in good position to meet changing economic conditions which the future may bring. High-producing cows and highly productive soils go hand in hand as good assurance of a sound basis for the future of dairy farming.

mated at that time that one-third of the cows of the country were kept at a loss, one-third paid expenses but made no profit, and only one-third returned a profit to their owners. Production per cow has increased somewhat since then, but many extremely low-producing cows are still kept. Recent census reports give the yield of cows in ten states as less than 3000 pounds of milk per cow; whereas in ten other states, namely, California, Connecticut, Idaho, Massachusetts, New

Jersey, New York, Oregon, Rhode Island, Washington, and Wisconsin, milk production was more than 5000 pounds per cow. The discussions in Chapter II emphasize the important relation of high production per cow to returns. One of the most important objectives in dairy farming, therefore, is a high yield from each cow in the herd.



FIG. 141. A DIVERSITY OF ENTERPRISES MAY PROVE PROFITABLE FOR THE DAIRY FARM

Feeder lambs sometimes find a place on dairy farms for the utilization of surplus roughage and for increasing the diversity of the farming enterprise. Yields of permanent pastures vary greatly depending upon the season, and the use of additional livestock for a short period sometimes may prove profitable.

2. PRODUCE A HIGH-QUALITY PRODUCT

Placing on the market high-quality products benefits the dairy farmer both directly and indirectly. High-quality products, such as Grade A milk and first-grade cream, not only command higher prices than lower-grade products but they also help to create a greater demand. Poor-quality butter and

other inferior dairy products cause customers to turn to other foods, thus lowering the prices of dairy products.

3. PROVIDE A DIVERSITY OF ENTERPRISES

Milk, as almost the sole product sold from the farm, introduces more risk into the business and in some instances has caused surpluses of milk on the market. Surplus milk, of course, commands lower prices than milk which is used for bottling.



FIG. 142. SOLID COMFORT

Winter's winds may whine and summer's sun may scorch, but this farm home is built to provide year-round comfort. It is one of the rewards for careful attention to the important factors affecting the returns from the farm business. The owner and occupant of this farm home is the proud possessor of a dairy herd which has an excellent dairy-herd-improvement-association record.

In some sections nearly all the milk is sold, and herd replacements are made by purchase. Separation of a portion or all the surplus milk into cream and skim milk and using the skim milk in raising the best heifer calves for herd replacements may sometimes improve market returns and lessen both cash expenses and risk.

The feeding of skim milk to pigs may also help to diversify and improve the farm business. For the same reasons, the

raising of some cash crops that do not remove large amounts of fertility from the soil may be justified.

4. CONSUME DAIRY PRODUCTS AT HOME

During the past few years there has been a rapid increase in the amounts of soybean oil and other vegetable oils used in food products. To a large extent foreign markets for dairy products produced in the United States have been lost, and there is constant pressure on our markets through the threat



FIG. 143. FARMING IS NOT ONLY A BUSINESS, BUT A MODE OF LIFE AS WELL

The use of vines, shrubs, and trees to beautify the farmstead adds to the pleasure of farm life. Not all the values of life or of farming can be reckoned in terms of dollars and cents.

of importation of foreign-produced dairy products. If dairy farmers are to meet these forms of competition effectively and to retain markets for their butterfat, cheese, and other dairy products, they must adopt the most efficient methods of production and must take an active interest in marketing their products. One of the greatest markets for dairy products should be the farm home. Unfortunately, however, some farmers defeat their own best interests by marketing dairy

products and buying competitive food products in their place. The consumption of more dairy products by farm families would have the two-fold effect of improving their health and their incomes.

5. HELP TO ADVERTISE DAIRY PRODUCTS

Dairy products are among the most valuable of all foods in the diet, not only for infants and children, but for adults as well. Many people, however, do not appreciate this fact and therefore do not purchase so large amounts of dairy products as they might.

A number of community advertising campaigns have effectively increased sales of dairy products. Advertising on a national scale, including educational programs in schools, commercials over the radio, sales talks before women's clubs and consumers' clubs, as well as printed advertising, could be financed by the contribution of only one cent for each 100 pounds of milk or one-fourth cent for each pound of butterfat sold from farms. This contribution would provide a fund of more than \$5,000,000 annually. No doubt distributors and manufacturers of dairy products would provide an equal amount. There is good reason for believing that such a program would greatly expand and stabilize the market for dairy products.

Unless dairy farmers do adopt measures that will provide for the greatest possible efficiency in production and take an active interest in their markets it is likely that they can not profitably continue to keep cows for the sale of butterfat. Markets for whole milk, on the other hand, are likely to offer better returns, although here, too, the highest efficiency in production and the improvement of markets through advertising and other means must be sought.

6. CONSERVE SOIL FERTILITY

A fertile soil is a priceless heritage. Thousands of years were required to build the naturally fertile soils of America, yet under some methods of farming, both the structure and fertility of the soils in numerous areas have ruthlessly been torn down within a generation. Millions of acres have been ruined for the usual types of farming. The exploitation and



FIG. 144. DRASTIC ACTION IS NEEDED TO CHECK SEVERE EROSION

The gully shown here is an example of the result of neglect and mistreatment of pastures. Overgrazing, depletion of fertility, invasion by weeds, crowding out of good grasses, and loss of a firm turf are steps that lead to erosion. No doubt this gully could have been prevented by careful management of this woodland pasture. The dam was constructed under supervision of the Soil Conservation Service.

mining of the fertility in a quick-cash-returns type of farming has helped to glut our markets with unwanted crop surpluses and has sold from the farms countless tons of fertility elements.

Dairy farming is essentially a soil-conservation type of farming. The use of erosion-preventing pastures and nitrogen-building legumes, the return of large amounts of manure from the feeding of roughages, grains, and purchased feeds, the planting of relatively few acres in tilled crops, and the selling of products low in fertility value, all make possible the use of a dairy farm for a generation without a decline in its pro-

ductive power. Unfortunately, however, many farmers have failed to appreciate the splendid opportunities for maintaining the productivity of their farms and through poor methods of management have permitted fertility to decline, erosion to become more and more intense, and finally the entire farm enterprise to be lost.



FIG. 145. LOSS OF FERTILITY INJURES PHYSICAL CHARACTERISTICS OF SOIL AND LOWERS YIELDS OF CROPS

This view of the Morrow Plots at the University of Illinois, looking south, shows in the immediate foreground a portion of Plot 3. All the plots were fall-plowed and were photographed on April 22. Note the wet, puddled condition of the soil which has lost most of its natural texture. Compare with Fig. 146.

This plot has grown 62 successive crops of corn without any soil treatment and without the application or return of any crop residues. The yield of corn for 12 years prior to 1938 was 24 bushels per year. Farther to the south a part of this plot on which soil treatment was applied yielded 42 bushels.

Most dairy-cattle enterprises are an intimate part of the entire farm business and can not readily be separated. Good returns from the herd are dependent upon good kinds and good yields of crops. A fertile and productive soil is just as necessary to successful dairy farming as high-producing cows.

Can not you, as a student of agriculture, by your example and through your influence in your community, help to give dairy farmers a new vision and a renewed faith in farming which will inspire them to pass on to the next generation a farm fully as fertile, and perhaps even more productive, than



FIG. 146. MAINTENANCE OF FERTILITY HELPS TO MAINTAIN CROP YIELDS AND TO RETAIN DESIRABLE PHYSICAL PROPERTIES OF THE SOIL

Looking north over the Morrow Plots, a portion of Plot 5 is shown in the immediate foreground. For 62 years the crops grown on Plot 5 have been a rotation of corn, oats, and red clover; and treatments of manure, lime, and phosphorus have been applied. Note the firm texture of the soil and the absence of puddling. This plot will dry off much more quickly and be ready for working much sooner than Plot 3 shown in Fig. 145. The pictures of the two plots were taken within a few minutes of each other.

The yields of crops on the treated portion of Plot 5 (immediate foreground) for the 12 years prior to 1938 were corn, 66 bushels; oats, 81 bushels; red clover, 2.6 tons. On the untreated portion of the plot the yields were corn, 43 bushels; oats, 55 bushels; red clover, 1.2 tons.

it was when they began to operate it? Surely, such an ambition on the part of dairy farmers could not fail in the long run to make dairy farming more profitable for both the present and future operators, and also would provide a mode of life second to none in happiness and contentment.

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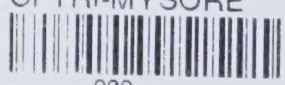
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